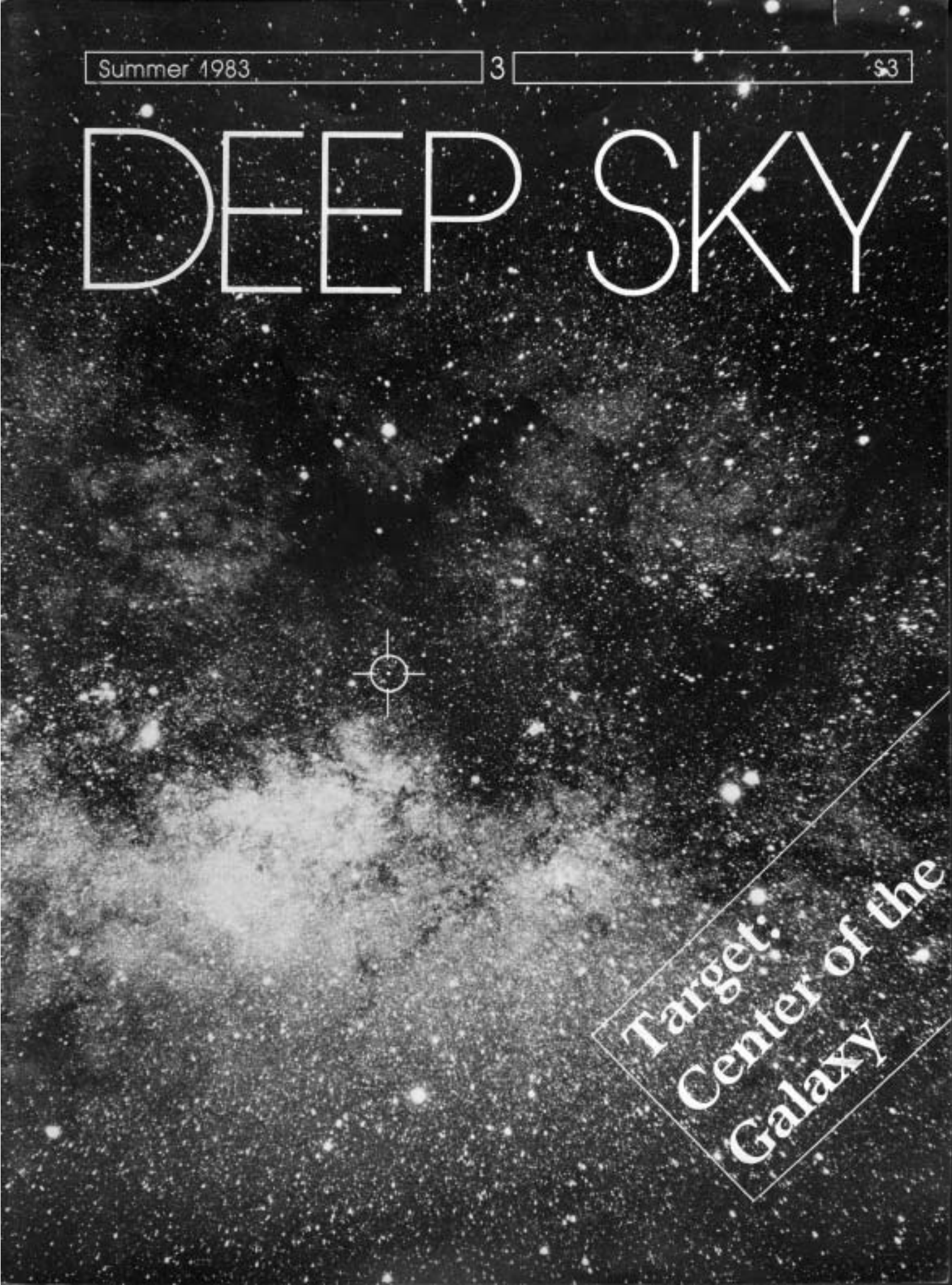
Summer 1983 3 $3

DEEP SKY



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DEEP SKY

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Summer 1983 Volume 1, Number 3

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Cover: When we look toward the constellation Sagittarius, we are looking toward the center of our Milky Way Galaxy. The actual nucleus of our Galaxy is obscured by enormous amounts of interstellar gas and dust. But we know that a powerful energy source lies there, perhaps even a supermassive black hole. This page: The finest object in the area is M8, a huge emission region. This sketch by Dave Eicher shows its appearance through backyard scopes.

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Letters to DSM

Remembering

Dear Dave/I received the Spring issue of DEEP SKY today. I'm very sorry to hear about the death of your mother. Do you remember John Brashear's self-written epitaph for himself and his wife? He said, "We have loved the stars too fondly to be fearful of the night." My thoughts and sympathies are very much with you.

Bob Ferris
Rt. 1, Box 50B
Littlerock, CA 93543

Let's See More Backyard Observations!

Dear Mr. Eicher/I've been a subscriber to your magazine for the past couple of years and have thoroughly enjoyed it. Its main value is sticking to deep-sky objects, allowing ASTRONOMY and *Sky and Telescope* to cover the rest of the astronomical field.

It seems that there aren't many photos and sketches of NGC objects available to amateurs, even in the big magazines. And when you deduct the Messier objects, the number dwindles to almost zero. While it is perfectly fine to state that objects lie at certain coordinates, still they are not easy to find and it greatly helps to have a photo or sketch of what you're looking for.

I hope that in your new format you will continue publishing photos and sketches of NGC objects, and not just the bright ones. I live amidst the bright skyglow of San Francisco, and your magazine has been a boon to me in finding many of these objects. Thanks for continuing an excellent magazine — it really fills a need.

Gordon W. Ridley
2427 Quintara Street
San Francisco, CA 94116

Mr. Ridley/Thanks for your comments on publishing amateur images. We'll continue to publish as broad a survey of deep-sky objects as possible. We now have a fairly extensive library of photographs and sketches, but will continually need more to give you the best possible magazine. (Hear that, observers and astrophotographers?)
— DE

Are Some Quasars Nearby?

Dave / The recent controversial paper by Jack Sulentic (*Astrophysical Journal Letters*, 15 February 1983) was of some interest to me both from the viewpoint of visual telescopic observation and because of the computer image-processing involved, which I do as part of my job at the U.S. Geological Survey in Flagstaff.

Briefly, the article attempts to show a physical connection between NGC 4319 and the QSO Markarian 205, located about 40 arc-seconds south of the main galaxy. The controversy arises because the redshift for Mk 205 is far larger than for 4319, implying a distance so great as to disallow any relation (redshift is correlated with distance in Big Bang cosmologies). Sulentic digitally scanned seven top-quality 5-meter Palomar and 4-meter KPNO plates. He then analyzed them on a computer using techniques similar to those involved in enhancing digital photographs returned by spacecraft such as Viking and Voyager. His results left me unconvinced, but I have seen first-hand how such image-processing can indeed pull "real" information out of a "noisy" scene. His conclusions could probably be confirmed by similar analysis of images taken with a CCD array or an electronic camera, both of which can record a large density (brightness) range between background and saturation.

As when any photographs of deep-sky objects are published in professional journals, I dug out observations of NGC 4319 from the card file my friend Chris Luginbuhl and I keep. Our observations were of special

Jack Sulentic

NGC 4319 & Mark 205

interest because on one occasion I made a sketch of the object and the surrounding field to accompany an article published in the May 1981 *DSM*. Somewhat to my surprise both the verbal notes and sketch (made with a 10-inch Newtonian) indicate a 14th magnitude "star" about one arc-minute south of the center of NGC 4319. Clearly from Sulentic's photographs this could only be Mk 205. The observed redshift of about 21,000 km/sec makes this galaxy the most distant object I have observed in terms of redshift velocity. On normal galaxies the usual limit with 10-inch aperture is 10,000 to 12,000 km/sec, which obtains for galaxies of blue magnitude 14.0 to 14.5. The very luminous quasars have much higher redshifts in this magnitude range.

There is also a good sketch of this field on page 182 in volume 4 of the Webb Society's *Handbook*. The individual galaxies aren't labeled however; NGC 4319 is toward the upper right, Mk 205 immediately above it, and the galaxy at lower left is NGC 4291, a brighter E-type galaxy.

Since the principal galaxies in the field are fairly bright (not too hard for 6-inches' aperture), many observers

may wish to observe these controversial objects for themselves. Those with very large instruments may be able to see Mk 205 as nebulous rather than merely stellar. Some catalogue information follows: **NGC 4319**, 12h 19.6m, +75° 36′ (1950); Zwicky magnitude 13.0; size 3.1′ x 2.5′ (from de Vaucouleurs); **Mk 205**, visual magnitude 15.24; B-V 0.40.

Can we read some results of observations of this object in the next issue?

Brian Skiff
421 West Aspen
Flagstaff, AZ 86001

Kudos for Galaxies

Dear Mr. Eicher/I just received the Spring issue of DEEP SKY and had to tell you how much I enjoyed it, especially the article entitled "Observing the Dipper's Galaxies." I've only observed M81 and M82 so far but on the next clear night I'll take out my telescope and DSM and try to locate some more of them!

I also enjoyed Mr. Chaple's list of 25 Spring doubles since observing them is one of my favorite activities. I will be renewing my subscription very soon since I'm sure future issues will be as enjoyable as this one. Keep up the great work.

Randy S. Lee
1479 South Elliston
Elmore, OH 43416

But How Long Do I Expose?

Dear Sir/I'm just starting to take photos of the sky with my 8-inch f/7 Newtonian and camera. If I want to take a photo of a 10th magnitude galaxy using 1000 ASA film, how can I figure out the best exposure time?

Michael Williams
2916 Mockingbird Drive
Sierra Vista, CA 85635

Mr. Williams/There is no perfect formula for calculating deep-sky astrophoto exposures because of the great number of variables involved. Different nebulae or galaxies have different surface brightnesses, and surface brightness varies over different parts of the same object. I've found that the best way to start is to look at the exposure times for various systems published with successful photos in magazines like DEEP SKY.

— DE

Confessions of a Photographer

Dear Sir/In DEEP SKY #1 I read with great interest the article on "How to Give a Slide Show." I always thought I gave pretty good slide shows but your article showed me that they could use some improvement. I sometimes break rule #1 by showing over 40 slides and more frequently rule #2 by taking longer than 20 minutes. I also remember saying "Here's the same thing from another angle" and "Here it is again."

Congratulations on a fine article. I hope to see more of Mr. Suiter's work in the magazine.

John Bartels
PSC 3, Box 6412
Travis AFB, CA 94535

Mr. Bartels/Thank you for your kind comments about my article in the recent DSM. I'm sure you give good slide shows. You'll remember that in the article I said that the rules could be broken "when appropriate." I didn't write that piece to stop people from showing 60 slides and an observatory "from another angle." I wrote it as a plea to some photographers who like to show 400 slides with 40 views of the observatory to let up on us poor audience members.

— Dick Suiter

"How-to" Articles

Dear Sir / I have received my trial issue of DEEP SKY and found it to be excellent. Novices like myself need all the guidance we can get. We need "how-to" articles such as "Observing Double Stars," "Standards for Reporting Local Sky Conditions," etc. Keep up the good work. Too often astronomy articles in other magazines are written which assume all amateur astronomers have been observing for years.

I hope to see future articles which will deal with astrophotography, film hypering, development, and copying. Please keep the novices in mind, especially those who live in cities and are not fortunate enough to have deep-sky observing sites.

Anthony Speca
9512 Croton Drive
Cincinnati, OH 45242

Inside View

An Era of Discovery

Bowell-Skiff

Nova Muscae 1983

IRAS-Araki-Alcock

As far as deep-sky objects go, the time of great visual discoveries ended with the Herschels and Barnards and Messiers. There simply aren't any unknown deep-sky objects that you could go out and discover. But still this is an era of discovery in our field: since DSM #2 was published, several important astronomical bodies have turned up.

At the New Year our friends in the Problicom blinking program struck paydirt when William Liller photographed a seventh magnitude nova in the southern constellation Musca. In February Contributing Editor Brian Skiff photographed a faint fuzzy object at Lowell Observatory which turned out to be Comet Bowell-Skiff, 1983c. Just two weeks ago as I write this we all learned about Comet IRAS-Araki-Alcock (1983d), which was the finest comet since West in 1976 and was widely observed and photographed. And at press time we have reason to believe that yet another comet, Sugano-Saigusa-Fujikawa (1983e), will brighten to naked-eye visibility before June.

Now these aren't deep-sky objects, you say. But they *look* like deep-sky objects. And although the clusters, nebulae, and galaxies plotted on our star atlases are known about, there are enough of them so that chances are they're still relatively mysterious to you. Take a sketchpad, a red flashlight, and a soft pencil out with you when you scan the skies. When you find an interesting object, sketch it critically and then check it on a map. You'll have "discovered" a deep-sky object for yourself!

Let me know how you're doing with finding and seeing the objects featured in DSM. We'll publish as many readers' sketches, photos, and comments as we can in future issues.

Dave Eicher
Editor

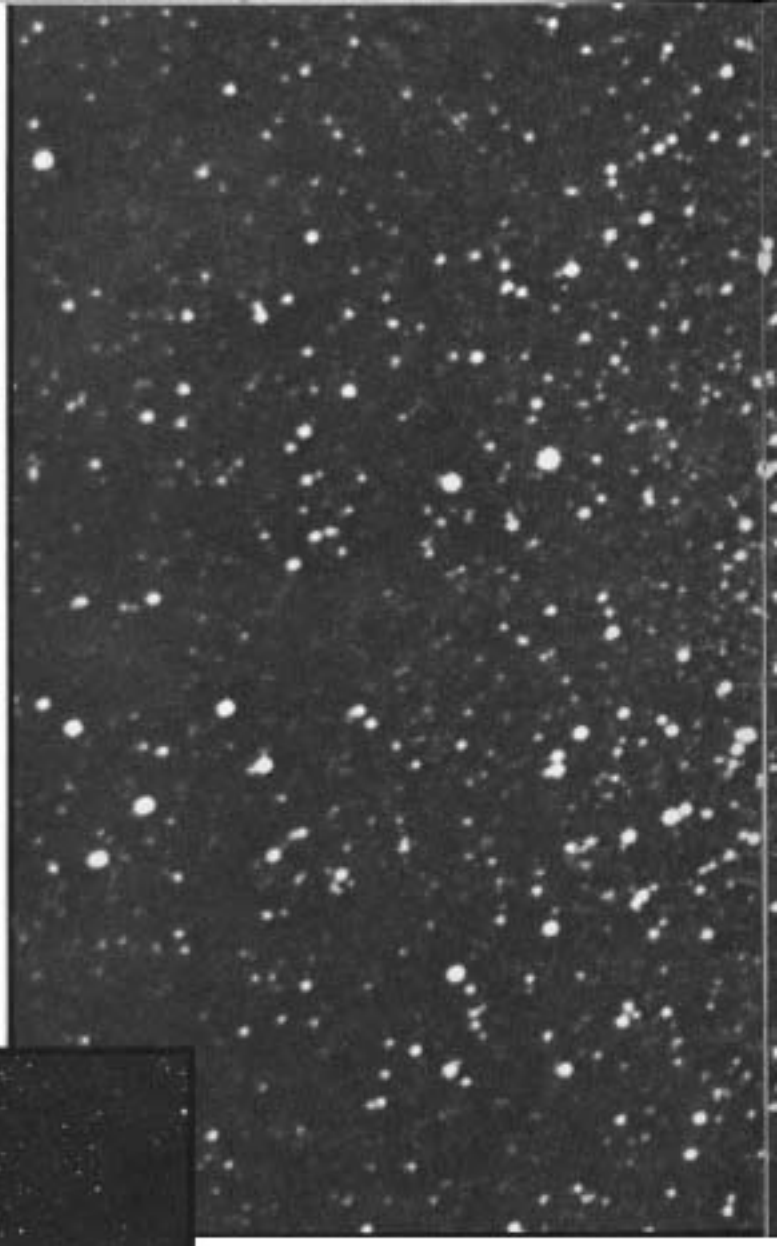
Looking to the Center of the Galaxy

by Phil Harrington

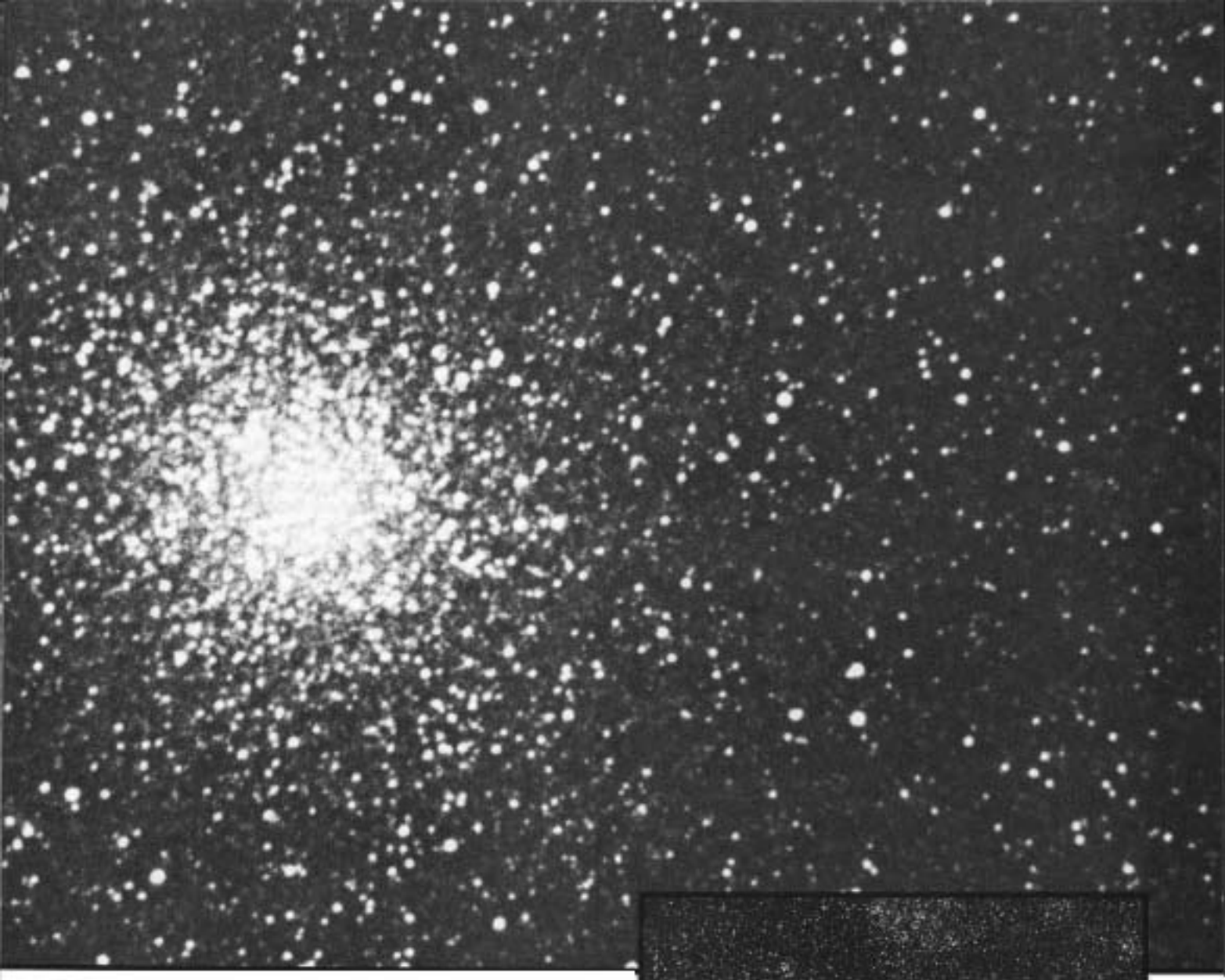
The summer Milky Way offers countless splendors for deep-sky observers. Scanning that hazy galactic glow with a rich-field telescope will reveal star fields of beauty unparalleled in any other seasonal sky. And many of the most fascinating summer objects lie in the constellation Sagittarius — toward the center of the Galaxy.

Probably the most spectacular object in Sagittarius is **M8** (NGC 6523), popularly known as the *Lagoon Nebula*. M8 is one of the finest examples of an emission nebula in the entire sky, and on dark moonless nights is easily visible to the naked eye as a hazy glow northwest of the Teapot's "spout." Four inch to 6-inch telescopes reveal a glowing cloud of great intricacy bisected by a dark lane, or "lagoon" of dust, and an 8-inch or 10-inch will begin to reveal some of the fainter portions of the nebula. But regardless of the telescope employed, a wide angle, low power eyepiece is a must for the best view, as M8 measures about 60′ x 35′ in size.

Charles Messier described M8 as "a cluster which looks like a nebula in an ordinary telescope of three feet [focus], but in a good instrument one observes only a large number of small stars." William Herschel described M8 as "an extensive milky nebulosity divided into two parts, the north



Right: **The giant globular cluster M22 contains half a million stars and is the third brightest such object in the sky. On nights of good seeing, 6-inch telescopes resolve it to the core. Photo by Marty Germano, who used his 8-inch f/10 SCT, 103a-F emulsion, and a 35 minute exposure.** *Below:* **Vast clouds of ionized hydrogen gas, emission nebulae M8 (the *Lagoon)* and M20 (the *Trifid)* shine ferociously in central Sagittarius. They are both superb targets for any telescope, although to see the faint bluish reflection nebulosity in M20 you'll need at least a 6-incher. Steve Reed took this photo on Palomar Mountain, with a 5.5-inch f/1.65 Schmidt Camera and TP 2415 film. The exposure lasted 15 minutes.**



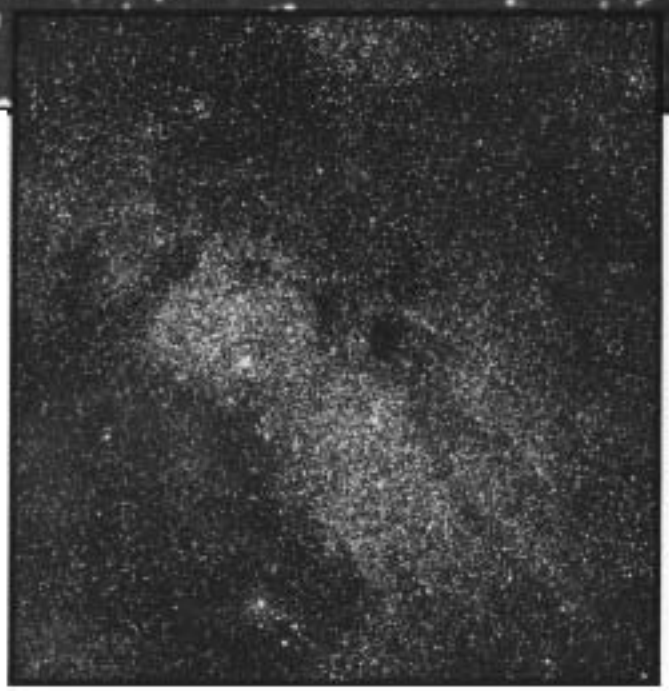
part being the strongest. Its extent exceeds 15 minutes," while LeGentil saw it as "a small nebulosity like the tail of a comet with numerous stars."

Messier's description of M8 is particularly interesting, as the open cluster NGC 6530 is located in the foreground. Might Messier have observed both objects, but logged only one? NGC 6530 consists of about two dozen stars of magnitudes 7 to 9, loosely gathered within a 10′ area. If viewed by itself, the cluster would be a fine object, but with the added beauty of M8, the view is striking indeed.

Located about two degrees northwest of M8 is another deep sky showpiece — **M20** (NGC 6514), the *Trifid Nebula*. Messier misidentified this as a star cluster, whereas William Herschel noted nebulosity that appeared to be divided by dark lanes. T.W. Webb thought that the nebulosity was "imperfectly seen by Smyth as well as myself."

Although many texts describe this as an unusually faint Messier object, I easily found it with 7x50 binoculars. In my 8-inch f/7 reflector, the nebulosity is obvious, the dark rifts easily seen with averted vision. Unlike M8 — which is best seen with low powers — M20 handles magnification well. It measures approximately 27′ x 29′ across, so try viewing it with eyepieces of 100x to 150x. Within the nebula is the triple star HN 40; the component stars are of magnitudes 7.0, 8.0 and 10.5, separated by 10.6″ and 5.4″.

Less than one degree northwest is the open cluster **M21** (NGC 6531). Using a wide field eyepiece, both this and M20



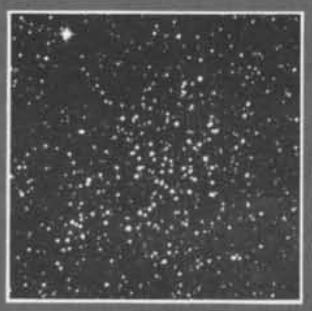
M24 is one of the largest Messier objects: it is a huge star cloud which is best observed with binoculars. The tiny open cluster on its eastern side is NGC 6603, and the dark patches are some of Barnard's dusty nebulae. Photo by David Healy, who exposed TP 2415 film for 15 minutes in his 8-inch f/1.5 Schmidt Camera.

Open Clusters in Sagittarius

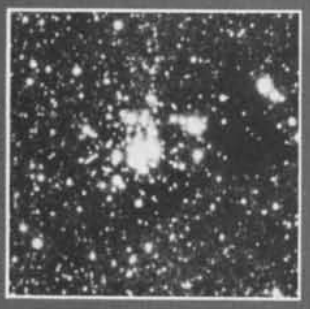
Martin C. Germano

A large bright scattered cluster, *M25* demands a wide field for viewing, and usually looks best through binoculars. It contains a cluster cepheid — U Sgr.

M23 is another large open cluster best seen at low powers. Although it is slightly fainter and smaller than M25, it contains twice as many stars and is consequently more compressed.



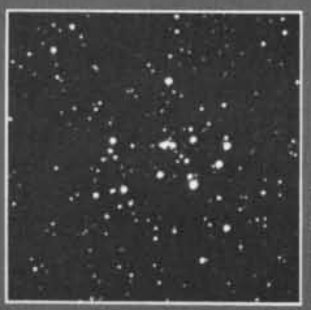
Lee C. Coombs



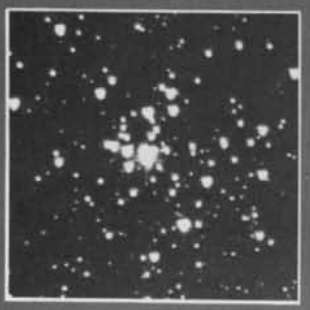
Lowell Observatory

Bordering on the edge of dark nebula B86 is *NGC 6520*, a rich open cluster containing 25 stars in an area only 5′ across. This cluster will stand high magnification.

Often accused of being one of the dullest Messier objects, *M18* is nonetheless worth seeing. It is a loose group of about a dozen bright stars.



Martin C. Germano



Lee C. Coombs

M21 is an interesting cluster that lies in the same low power field as the Trifid Nebula. It is pretty bright, and contains three dozen stars in an area spanning 12′ across.

may just squeeze into the same field of view. The Webb Society *Handbook,* Volume 3 states that M21 contains some sixty stars of eigth magnitude and fainter. In the 8-inch, I counted about 25 stars of magnitude 8 to 12 over a 10′ area. With the cluster lying approximately 3,000 light-years away, this would indicate a true diameter of 10 light-years.

In the northwest corner of Sagittarius is another worthy open cluster: **NGC 6469**. Though not as spectacular as M21, it is still a fine object in amateur instruments. In the 8-inch I saw 15 stars brighter than magnitude 11, although I suspected many more unresolved faint stars. Scattered over a 10′ area, the cluster members form a triangular shape.

NGC 6440 is a small globular cluster positioned near the Sagittarius/Ophiuchus border. The 8-inch revealed a tenth magnitude globe of unresolved stars. Just northeast is the planetary nebula **NGC 6445**, over which there is some disagreement about its magnitude. Burnham lists it at magnitude 13, but the Webb Society comes in at magnitude 9.5. My notes from the 8-inch Newtonian suggest that it is a large bright whitish nebulosity — I thought at about magnitude 10.5 — with no visible central star. (Which is not surprising, since I later discovered that the central star glows at a dim 19th magnitude.)

Continuing northeastward you will come upon **M23** (NGC 6494). This is a spectacular open cluster regardless of the instrument you observe it with. Six- to 8-inch scopes show a large, rich cluster with over 50 stars of magnitude 9 and fainter; a 6th magnitude star appears just beyond the northwest corner of the grouping.

M23 was discovered by Messier in 1764. The famous 19th century observer Admiral William Smyth described it as a "loose cluster, an elegant sprinkling of telescopic stars over the whole field under moderate magnification."

For observers with moderate sized telescopes, **NGC 6520** offers an interesting sight. Lying some two degrees north of Gamma (γ) Sagittarii, an 8-inch to 10-inch will reveal 20 to 25 members of magnitude 9 to 12 within an apparent diameter of 5′. What makes NGC 6520 even more interesting is its neighbor: the dark nebula **Barnard 86** sharply contrasts with the surrounding star field, thereby making it relatively easy to find. Look for a roughly triangular-shaped "hole" measuring about 3′ x 4.5′ — that will be B86.

One degree east of this pair is the open cluster **NGC 6540**, a somewhat unimpressive sight consisting of only about ten 10th to 11th magnitude stars. Overall the group measures about 1′ in diameter, making it one of the poorest clusters in Sagittarius.

Just north of γ Sagittarii is a pair of faint globular clusters. The brighter of the two, **NGC 6522**, is small and faint with a gradual brightening toward its center. In the 8-inch the cluster is unresolvable, shining at magnitude 11.5 and with a diameter of 3′. **NGC 6528**, visible in the same field, is uniform in appearance, somewhat smaller and fainter than its neighbor. Both consist of stars fainter than magnitude 15, and therefore are resolvable only in large instruments. Incidentally, due to their close apparent position to γ Sgr, these clusters are easy to locate, but hard to observe. Be sure to keep the bright star out of the field of view so that its light does not scatter into the telescope's optical path and drown out the clusters.

NGC 6544 is a small globular cluster just southeast of M8. Still farther southeast is another globular — **NGC 6553**. Overall, the appearance of these two objects is quite similar. With the 8-inch, I saw both as small 11th magnitude globulars showing some central brightening but no resolution. These descriptions pretty well agree with those in Burnham's *Handbook*, though he lists NGC 6544 as a magnitude 9 object and NGC 6533 at 10th magnitude.

Continuing our sojourn through Sagittarius, the next stop is **NGC 6559**. This is the brightest of a group of diffuse nebulae just west of the star 11 Sagittarii. Though undetected in the 8-inch, Volume 2 of the Webb Society's *Handbook* lists it appearing large and bright in a 16½-inch instrument. Other

members of this complex of emission and reflection nebulosity include **IC 1274**, **IC 1725**, **IC 4678**, **IC 4681**, **IC 4684** and **IC 4685**. All of these objects are rather faint, and probably difficult to observe unless you have a large aperture, low power scope and excellent transparency. Just east of IC 1274 is a dark cloud known as **Barnard 91**; astronomers suggest that this entire area may be a part of the Lagoon-Trifid complex of nebulosity.

South of γ Sgr is **NGC 6558**, a mysterious cluster. The Tirion and Skalnate Pleso atlases both show it as an open cluster, but Burnham states it is a globular, mentioning that it may be a compact open cluster. Regardless of its type, NGC 6558 shines at magnitude 11, and is moderately faint, quite small and very rich. East of 6558 is another cluster: **NGC 6569** is a fairly bright globular, conspicuous in a 4-inch telescope. You'll need a large instrument to resolve individual stars, as the brightest are listed at magnitude 15.

Moving two degrees farther south, we find **NGC 6563**. This planetary nebula presents a challenge to all observers due to its brightness and size (magnitude 13, 50″ x 35″, respectively). While it is possible to glimpse the nebula in an 8-inch, I couldn't see it under good conditions at Stellafane in Vermont. Can any observers pick up this elusive object in an 8-inch telescope?

Let's now focus upon another deep sky showpiece. **M17** (NGC 6618) lies right along the boundary with Sagittarius, Scutum, and Serpens Cauda. Known as the *Omega* or *Horseshoe Nebula*, M17 is a vast emission region of ionized hydrogen — a spectacular sight in any telescope, largely due to its very high surface brightness. It is very bright, and will take magnification well. A 3-inch or 4-inch scope reveals the familiar "2" figure, while larger instruments show progressively more detail in the cloud's structure. M17 was discovered in 1764 by the Swiss astronomer Philippe de Chesaux, and independently found by Messier later that year. Both described it as long and thin, like a comet-less tail.

Just south is the next entry in Messier's list. **M18** (NGC 6613) is infamous as one of the least impressive Messier objects. Through the 8-inch I saw a small, fairly bright group, containing perhaps a dozen stars, none of which appeared brighter than 9th magnitude.

South of M18 is the star cloud **M24**, one of those ill-defined Messier objects. Many lists identify the small open cluster NGC 6603 as M24, however Messier's own description indicates it to be a patch of the Milky Way: "A large nebulosity in which there are many stars of different magnitudes; the light which is spread throughout this cluster is divided into several parts; diameter 1°30′." Hence Kenneth Glyn Jones of the Webb Society is almost certainly correct in suggesting that M24 is the entire star cloud within which the cluster lies. A richest-field telescope or binoculars are your best bet for observing this huge patch of "milky" stars, which measures 120′ x 40′ in extent. Be sure to scan the surrounding fields with low-power instruments — they're particularly stunning on dark, clear summer nights.

NGC 6603 must, therefore, be considered a separate object. It appears as a small, rich open cluster of about magnitude 11. Though visible in a 6-inch as a glow within M24, you'll need a 10-inch to resolve the individual stars.

Located on the northwest corner of M24 is the dark nebula **Barnard 92**. Set against a magnificent field of distant suns, the dust cloud shows up well in a 6-inch instrument. The stark contrast is best seen with a low power eyepiece. Look for a black "hole" about 15′ in diameter.

Between M24 and Mu (μ) Sagittarii lies another group of reflection nebulae. **NGC 6589** and **NGC 6590** are the brightest, although they are still difficult targets. Using a 16½-inch reflector, observer Malcolm Thomson noted, in Volume 2 of the Webb Society's *Handbook*, that 6590 appears as a "bright oval nebula containing two stars of equal magnitude." NGC 6589 showed up in the same scope as "two stars in a faint, irregular nebula." Another, fainter, section of the nebulosity is **IC 1283/4**. Observers who don't

Globular Clusters in Sagittarius

M54 is a bright, small globular lying in the southern end of the Teapot. You'll have to use a 10-inch or 12-inch instrument to begin to resolve this cluster.

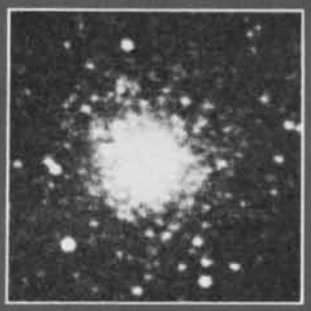
Martin C. Germano

Jack Newton

One of the largest and easiest-to-resolve globular clusters is *M55*. This giant globe of suns contains a huge number of very faint stars, and a smattering of brighter ones.

Much larger and not as condensed as M75 is *M28*, a globular that lies less than a degree away from λ Sgr. The cluster suffers from about 2½ magnitudes' dimming by the Milky Way's obscuring dust.

Thomas L. Dessert



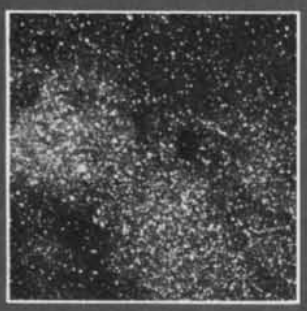
Martin C. Germano

M75 is a small but rich globular in eastern Sagittarius. It is an eighth magnitude globe in the eyepiece, and is very difficult to resolve. Use high powers on this cluster.

Similar in brightness to nearby M70, globular *M69* is a small, inconspicuous cluster. Lacaille, who discovered this group of stars, likened it to "the small nucleus of a comet."

Thomas L. Dessert

Nebulae in Sagittarius



Ronald Royer

Barnard 92 and *Barnard 93* are two large dark nebulae located within the star cloud M24. Use a wide field eyepiece and look for "holes" in the backdrop of glistening stars.

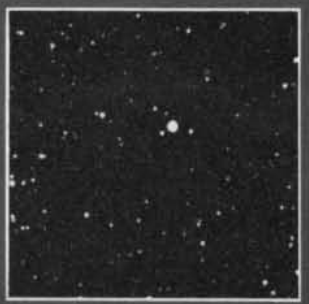
M17, the *Omega Nebula*, is one of the brightest emission regions in the sky, and is famous for its high surface brightness. Can you trace out any of the faint gas?

John E. Aydelotte

Martin C. Germano

An odd, faint planetary nebula, *NGC 6445* is unspectacular in all but large backyard scopes. It glows at only 13th magnitude, so use at least a 6-inch scope.

A planetary considerably brighter than 6445 is *NGC 6818*, a 10th magnitude greenish disk which lies near Local Group member NGC 6822. Can you detect an elliptical shape?



Jack Newton

Greg W. Griffith

M20 is the famous *Trifid Nebula*, a delightful target in any telescope. The wispy greenish gas has a fairly low surface brightness, so it appears dim (albeit pretty) in small scopes.

have large scopes may be disappointed in this region, but it offers a vast cloud of intricate beauty for astrophotographers.

NGC 6568 and **NGC 6583** are two open clusters located on either side of the star 14 Sagittarii. NGC 6568 appears as a moderately large, weak conglomeration of 20 to 25 stars of magnitude 11; NGC 6583 looks much richer even though it contains about the same number of members, an effect enhanced by the comparatively small apparent size of NGC 6583. A 6-inch scope is more than adequate to resolve both of these relatively faint objects.

Another pair of objects worthy of scrutiny by observers with larger telescopes is **NGC 6578** and **NGC 6567**, two planetary nebulae. NGC 6578 is one of those "easy-to-locate-but-hard-to-find" objects. It lies just north of 5th magnitude star 16 Sagittarii, which makes it easy to locate, but as it's at magnitude 13, only those with a 10-inch or larger instrument will be able to glimpse it. Even then, high magnification is necessary to differentiate it from a star, since the disk is only 8″ in diameter. NGC 6567 may be spotted in a 6-inch, though it can hardly be considered "easy." In the 8-inch, I saw it as a stellar object at 54x, but at 240x the nebula looked decidedly oval. Be sure not to confuse the planetary for the faint star which is almost superimposed on it. At low power, the two give the impression of a double star, each component shining at 12th magnitude.

Less than a degree southeast from Delta (δ) Sagittarii is **NGC 6624**. This is a bright, pretty large globular cluster that is visible in 10x50 binoculars. In the 8-inch I saw it as a round object with a somewhat brighter core. A 14-inch or 16-inch scope will resolve some of the individual cluster members, the brightest being 16th magnitude specks of light.

A very large and bright globular cluster is **M28** (NGC 6626), discovered by Messier in 1764, and incorrectly identified by him as a "nebula containing no star." William Herschel described M28 as "very bright, round, very much compressed, resolved into stars of magnitude 14-15." In the 8-inch at Stellafane in 1974, I partially resolved the edges with relative ease. Under the mediocre conditions of Long Island, I can't do this. Using the Westport (Connecticut) Astronomical Society's 12½-inch Newtonian at Rolnick Observatory, the cluster appeared much more resolved. While it's a fine sight for moderate-to-high powers, M28 is overshadowed by a celestial neighbor: M22.

M22 (NGC 6656) is one of the most spectacular globulars in the heavens. Under ideal conditions it is visible to the unaided eye as a hazy spot northeast of Lambda (λ) Sagittarii. A 3-inch reflector begins to resolve the brighter individual members, and an 8-inch shows an uncountable number of stars spanning the face of the cluster; for northern hemisphere observers, a sight equalled — but not surpassed — only by M13 in Hercules. Were it not for its southern declination, M22 might be the standard by which all other globulars are judged, rather than the Hercules cluster. M22 contains half a million stars in a 50 light-year diameter, and astronomers at Mount Wilson actually counted 75,000 stellar images on a single photographic plate! It probably lies about 10,000 light-years away, making it one of the nearest globulars.

Within a few degrees of M22 lie several deep sky objects to challenge observers with medium sized scopes. The brightest is **NGC 6642**, a globular located about 1½° northwest of M22. An 8-inch shows a round 8th magnitude glow about 3′ in diameter, with a brighter core. The group's individual stars are no brighter than 15th magnitude, so very large amateur scopes are needed to see the true nature of the object.

Nearby, you can find another globular cluster hanging in view. It is about the same size as NGC 6642, but **NGC 6638** is somewhat harder to find since it shines at magnitude 10. Look for a hazy orb with a slightly brighter center; I couldn't detect any individual stars using the 12½-inch at Rolnick Observatory. Like so many of the fainter globular clusters,

you'll need a pretty large scope to resolve the group.

The other objects in this region are planetary nebulae. The brightest is **NGC 6629**, lying 2½° west of M22. The 8-inch at 210x reveals a small round disk about 10″ in diameter with a magnitude of about 11. You'll probably need at least a 10-incher to see the 14th magnitude central star — what is the smallest scope that can pick it up? **NGC 6644** is extremely difficult to locate in any telescope. Burnham lists it as a 12th magnitude object only 2″ in diameter, giving it a stellar appearance at all but the highest powers.

If you thought NGC 6644 was hard to locate, try finding **IC 4732**, a planetary just northwest of M22. Rated at 13th magnitude and 2″ in diameter, a 16-inch scope is probably the smallest that can detect it. Even then, you'll have to "crank up" to high power to detect it as a nebula visually.

Following a zig-zag line between Epsilon (ε) Sagittarii and Zeta (ζ) Sagittarii, we can find five more deep-sky objects. Moving from west to east, first we find **M69** (NGC 6637), a globular discovered by Lacaille in 1752. Messier first saw it eight years later, when he described it as "a nebula without a star . . . near it is a 9th magnitude star." Many years later, John Herschel could "clearly resolve" this globular cluster into individual stars using an 18-inch reflector. In my 8-inch reflector, M69 appeared as an 8th magnitude globe showing some central resolution at 235x. Its apparent diameter of 3′ probably represents a distance of around 25,000 light-years.

Nearby is another 8th magnitude globular — **NGC 6652**. An 8-incher reveals a fairly bright object about 4′ diameter, with some central concentration but no resolution. A 12-inch telescope is probably the smallest instrument able to resolve some of the 15th magnitude component stars.

Still farther east along the line is the distant globular cluster **M70** (NGC 6681). In my 8-inch scope this group of suns appears as a pretty bright object with easily resolved edges, and closely resembles M69. A smaller instrument shows a round nebulous patch, whereas a 10-inch or larger scope more fully resolves the individual stars. M70 is about 65,000 light-years away, over twice the distance of its look-alike neighbor.

IC 4776 is a faint planetary nebula south of M70. This target is a challenge: it faintly radiates at magnitude 12.5 and measures 6″ x 8″ in size. What is the smallest telescope required to identify it? I have failed to glimpse it with my 8-inch on several occasions. Perhaps given a more southerly observing site, an 8-incher will pull it in with ease.

The final stop along the line between Epsilon and Zeta is **M54** (NGC 6715). While M54 is considered a bright globular cluster (magnitude 7), it is very concentrated and therefore difficult to resolve. In the 8-inch at 54x, the object appears as a nebulous disk with little hint as to its true nature. Only when I employed 310x did I begin to resolve a few individual stars. Perhaps a 10-inch or 12-inch scope does justice to this 50,000 light-year distant swarm. Like neighboring M69 and M70, M54 is receding from us at nearly 200 kilometers per second.

Some 5° north of M22 is another member of Messier's catalogue. **M25** (IC 4725) is a bright open cluster containing several dozen stars more luminous than 12th magnitude scattered over a ½° field. M25 is unique in two respects. First, it is the only M-object to be listed in the Index Catalog (IC). Second, it is one of a handful of open clusters to contain a Cepheid variable. **U Sagittarii** varies between magnitudes 6.3 and 7.1 over a period of 6.745 days. Although the variation is quite subtle, a practiced eye can estimate the star's period quite accurately.

NGC 6645 is a rich open cluster positioned 2½° north of M25. A moderate-sized amateur instrument displays the cluster as a gathering of about 70 stars, most of which are magnitude 11 and 12. The member stars extend over the 10′ diameter, making this a fine target for medium powers. In Volume 3 of the Webb Society's *Handbook*, observer Pat Brennan notes that within NGC 6645 is a fairly bright triple star.

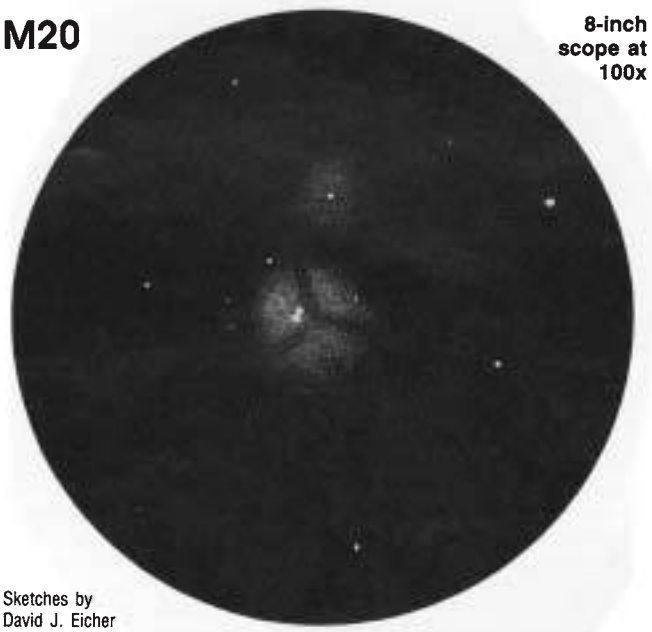
NGC 6774 is an open cluster spanning nearly ¼°. The member stars are of 12th magnitude, making it very easy to pass right over without notice. Because of its weak concentration, in fact, some astronomers suggest that this is not a true cluster at all. From what I saw, I tend to agree, but judge for yourself. Is this a star cluster, or only a moderately rich star field?

For variable star observers, Sagittarius abounds with interesting targets. **R Sagittarii** is a Mira-type variable. Over its 269 day period, the star fluctuates between visual magnitudes 7.3 and 12.5. Due to this wide range and bright maxima, R Sgr is an excellent star for whetting your appetite for variable star estimating. Another interesting long period variable is **S Sagittarii**. It has a period of 231 days, and varies between magnitude 9.3 and fainter than 15. S Sgr is spectrally classified as M4, typical of many long period stars.

RY Sagittarii is an R Coronae Borealis-type variable. This indicates that the star has an irregular period of fluctuations, similar to R CrB itself. The star usually remains at maximum brightness — about magnitude 6. Suddenly its brightness will drop, fading to fainter than magnitude 15. This effect, astronomers suggest, is caused by carbon "soot" in the star's

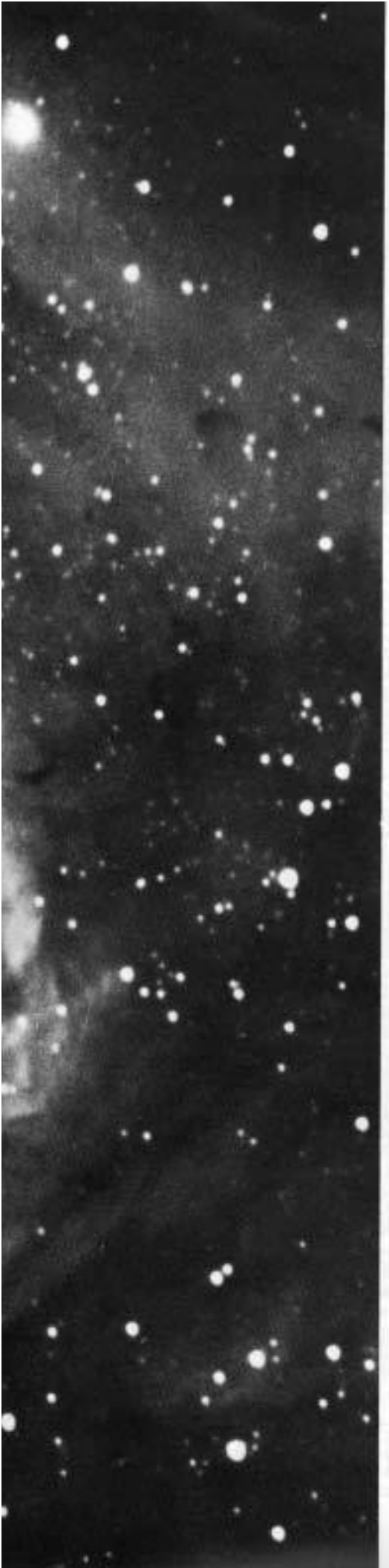
M28 **8-inch scope at 100x**

M20 **8-inch scope at 100x**



Sketches by David J. Eicher

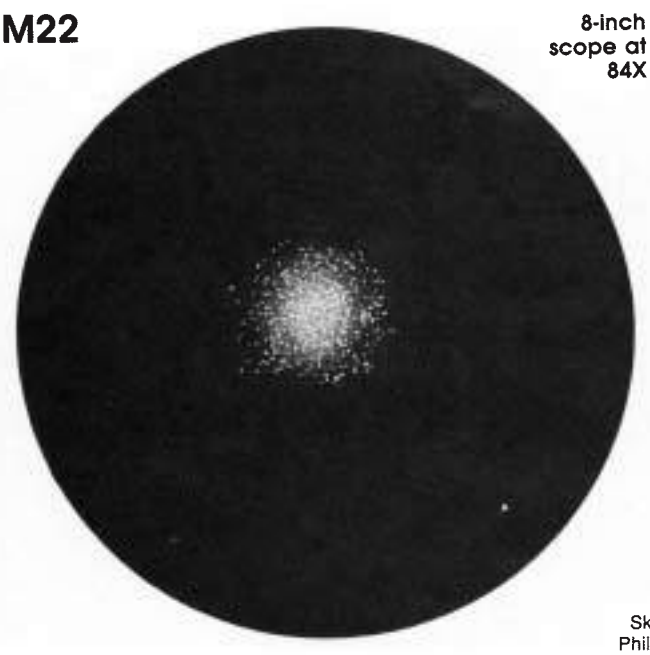
One of the most observed of all deep-sky objects, the Lagoon Nebula is an enormous region of ionized hydrogen. With fairly large amateur telescopes, on nights of excellent seeing, you'll be able to pick out some of the dark "Bok globules" and faint wispy nebulosity far out from the "hourglass" at the nebula's center. David Healy made this photo using his 14-inch f/7 SCT, hypered TP 2415, and a 24 minute exposure.



Deep Sky Targets Toward the Galactic Center

NGC/M	R.A.	Dec.	Type	Mag.	Size
6440	17h 45.9m	−20° 21′	●	12.0	1′
6445	17 46.3	−20 00	■	13.0	35″ x 30″
6469	17 49.9	−22 20	⊙	8.0	12′
M23 (6494)	17 54.0	−19 01	⊙	6.0	27′
M20 (6514)	17 58.9	−23 02	□ER	5.0	29′ x 27′
B86	18 00.0	−27 50	□D	—	4.5′ x 3.0′
6520	18 00.3	−27 54	⊙	7.5	5′
6522	18 00.4	−30 02	●	10.5	2′
M8 (6523)	18 01.6	−24 20	□E	5.0	60′ x 35′
6530	18 01.6	−24 20	⊙	7.5	14′
6528	18 01.6	−30 04	●	11.0	1′
M21 (6531)	18 01.8	−22 30	⊙	7.0	12′
6540	18 03.1	−27 50	⊙	14.5	1′
6544	18 04.2	−25 01	●	—	1′
IC 1274	18 05.1	−23 41	□E	—	12′ x 8′
1275	18 05.1	−23 51	□E	—	—
4678	18 05.2	−23 27	□E	—	—
4681	18 05.2	−23 27	□E	—	—
4684	18 05.2	−23 27	□E	—	—
4685	18 05.2	−23 27	□E	—	—
B91	18 05.6	−23 27	□D	—	—
6553	18 06.3	−25 56	●	10.0	2′
6559	18 06.8	−24 08	□E	—	8′ x 6′
6558	18 07.0	−31 46	●	11.0	2′
6568	18 09.8	−21 36	⊙	8.5	15′
6569	18 10.4	−31 50	●	10.5	2′
6567	18 10.8	−19 05	■	11.5	11″ x 7″
6578	18 11.9	−20 18	■	13.5	8″
B92	18 12.7	−18 20	□D	—	15′
6583	18 12.8	−22 09	⊙	12.0	2′
M24	18 13.0	−18 30	SC	4.5	120′ x 40′
6603	18 15.5	−18 27	⊙	11.5	4.5′
6589	18 15.5	−19 39	□R	—	—
6590	18 15.5	−19 44	⊙	—	—
IC 1283	18 15.5	−19 50	□R	—	—
IC 1284	18 15.5	−19 50	□R	—	—
M18 (6613)	18 17.0	−17 09	⊙	8.0	7′
M17 (6618)	18 18.0	−16 12	□E	7.0	46′ x 37′
6624	18 20.5	−30 23	●	9.5	3′
M28 (6626)	18 21.5	−24 54	●	8.5	15′
6629	18 22.7	−23 14	■	12.0	16″ x 14″
6638	18 27.9	−25 32	●	10.0	2′
M69 (6637)	18 28.1	−32 23	●	9.0	4′
M25 (IC 4725)	18 28.8	−19 17	⊙	6.2	35′
U Sgr	18 28.9	−19 10	CV	6.3→7.1	—
6642	18 28.9	−23 31	●	10.5	1′
6644	18 29.5	−25 11	■	12.0	2″
6645	18 29.8	−16 56	⊙	8.5	10′
IC 4732	18 30.9	−22 42	■	13.0	2″
6652	18 32.5	−33 02	●	10.0	2.5′
M22 (6656)	18 33.3	−23 58	●	6.5	17′
M70 (6681)	18 40.0	−32 21	●	9.0	4′
IC 4776	18 42.6	−33 23	■	12.5	8″ x 6″
M54 (6715)	18 52.0	−30 32	●	8.5	5.5′
6723	18 56.2	−36 42	●	7.5	7′
6726	18 58.3	−36 57	□E	—	—
6727	18 58.3	−36 57	□E	—	—
6729	18 58.5	−37 02	□E	—	—
RY Sgr	19 13.3	−33 37	IV	6.0→15.0	—
R Sgr	19 13.8	−19 24	LPV	7.3→12.5	—
6774	19 13.9	−16 21	⊙?	11.5	25′
S Sgr	19 16.5	−19 07	LPV	9.3→15.0	—
M55 (6809)	19 36.9	−31 03	●	7.0	15′
54 Sgr	19 37.9	−16 25	★²	5.5+8.5	—
6818	19 41.1	−14 17	■	10.5	22″ x 15″
6822	19 42.1	−14 53	#	10.0	17′ x 13′
6835	19 51.8	−12 42	()	13.5	2′ x 0.5′
M75 (6864)	20 03.2	−22 04	●	9.5	4.5′
6878	20 10.3	−44 41	§	13.5	1.2′ x 0.9′
6890	20 14.8	−44 58	()	13.5	1.2′ x 1.0′
New 5	20 21.0	−44 10	§L	12.5	1.4′ x 0.5′
6902	20 21.2	−43 50	⸗	12.5	0.9′ x 0.7′

★² = double star; CV = Cepheid variable; IV = irregular variable; LPV = long period variable; SC = star cloud; ⊙ = open cluster; ● = globular cluster; ■ = planetary nebula; □E = emission nebula; □R = reflection nebula; □D = dark nebula; § = spiral galaxy; ⸗ = barred spiral galaxy; () = elliptical galaxy; §L = lenticular galaxy



Sketches by Phil Harrington

atmosphere, which causes a temporary blockage of light. As the soot dissipates, the star gradually returns to its usual brightness.

Of all the deep sky objects in eastern Sagittarius, **M55** (NGC 6809) is the most spectactular. In 1752 Nicholas de Lacaille discovered this giant globe of stars while he was observing from the Cape of Good Hope. Messier first saw it in 1778 as "a nebula which is a whitish spot; extending for 6′ around, the light is even and does not appear to contain a star." My modern-day 8-inch scope at 125x shows a large, bright sphere with many stars resolved. M55 has an apparent diameter of 15′, though its full extent is difficult to trace out in the same 8-incher. At its estimated distance of 20,000 light-years, the globe has a real diameter of about 90 light-years.

Located less than half a degree from the Capricornus border is **M75** (NGC 6864). This object has the distinction of being the most remote globular cluster listed in the Messier catalog, at an estimated distance of 95,000 to 100,000 light-years. Visually, M75 is a bright, compact object. I couldn't resolve it through the 8-inch, and larger telescopes only do slightly better since the stars are 15th magnitude specks. Small telescopes show a perfectly round glow about 5′ across.

The brightest planetary nebula within Sagittarius is **NGC 6818**. Lying at a distance of about 3,000 light-years, this is perhaps one of the most underrated planetaries. The 8-inch offers a captivating view of a bright oval disk, with a major axis elongated in position angle 10°/190° and having a bluish-green hue. Maybe one reason for the seeming lack of interest in 6818 is a lack of bright stars nearby. The closest two are 5th magnitude 54 and 55 Sagittarii; the former is a double star, easily separable in binoculars. The components shine at magnitudes 5.5 and 8.5, and are separated by 45.6″. The spectral classes of the two stars are K2 and F8, respectively, offering a colorful contrast to each other.

NGC 6818 makes a good starting point to locate **NGC 6822**, less than a degree to the southeast. This is *Barnard's Galaxy*, named after its discoverer, E.E. Barnard, who spotted it in 1884. Barnard's Galaxy is a challenging object for observers in the mid-northern latitudes for many reasons. Due to its low altitude and large apparent size, you'll have to have virtually no interference from skyglow to see it. I've unsuccessfully searched for it many times with the 8-incher from Connecticut, but finally found it with the same scope at Stellafane in 1981. It appeared as an irregular oval shape, with a major axis running north-south, and measuring 20′ x 10′. Very large scopes may be able to pick out some of the 15th magnitude member stars, but its notoriously low surface brightness causes trouble for many observers. At an estimated distance of about 1.7 million light-years, NGC 6822 is well within the limits of the Local Group. Photographs reveal what is suspected visually: that this is an irregular galaxy, similar in appearance to the Magellanic Clouds.

Located along the southern boundary of Sagittarius is **NGC 6723**. This is a bright, compact globular cluster, which undoubtedly would be better known to us were it not for its southern declination. If you have a clear view of NGC 6723 and a 10-inch or larger scope, you can probably spot individual stars, some of which are as bright as 14th magnitude. The cluster itself shines at magnitude 7, and lies less than a degree away from a complex of nebulosity, listed as **NGC 6726/7/9**. This irregular nebulosity is in Corona Australis, and contains the irregular variable stars R, S, T and TY Coronae Australis.

Although by looking toward Sagittarius we're gazing at the center of our Galaxy, the constellation holds a few faint galaxies, dimmed by interstellar dust and gas. Nestled in the northeast corner of the Archer is a faint, little-noticed elliptical galaxy, **NGC 6835**. Classified as E8, it appears as a cigar-shaped nebulosity; its light is equivalent to a 13th magnitude star, and it measures a mere 2′x0.3′ in size.

Visible in only the southern latitudes of North America is a group of four galaxies tucked just inside the southeastern corner of Sagittarius. The brightest — at magnitude 12.4 — is **NGC 6902**, followed by **New 5** (magnitude 12.4), **NGC 6890** (magnitude 12.7) and **NGC 6878** (magnitude 13.1). All are plotted on Tirion's *Sky Atlas 2000.0*, and all but NGC 6878 are in Becvar's *Atlas of the Heavens*. These are challenging finds for even the most-accomplished deep sky observers.

The celestial Archer holds challenges for all observers, regardless of their telescopic equipment. Not surprisingly, the Galactic center offers a wide variety of Milky Way objects: indeed, Sagittarius is *the* constellation for deep-sky hunters. As you search out the clusters, nebulae, stars and galaxies found in this section of the sky, make records of what you've seen. Written descriptions, sketches, and photographs will become invaluable for the future. You'll gain more and more experience and knowledge every time you return to the center of the Galaxy.

Phil Harrington is a professional designer for a marine engineering firm and a staff member at the Vanderbilt Planetarium. He is an active deep-sky observer and is involved in the Westport Astronomical Society.

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"I have a 10" f/5 scope and am a deep-sky fanatic (funny considering my location), and one of my fetishes was seeing the Veil Nebula. I must've searched that region 100 times, using different eyepieces, averted vision, hoods and never got anything. Then I popped your UHC in my 21mm Plossl. ***My God!*** *It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*

Rich Zepernick, Cresskill, NJ

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Scanning the Summer Skies

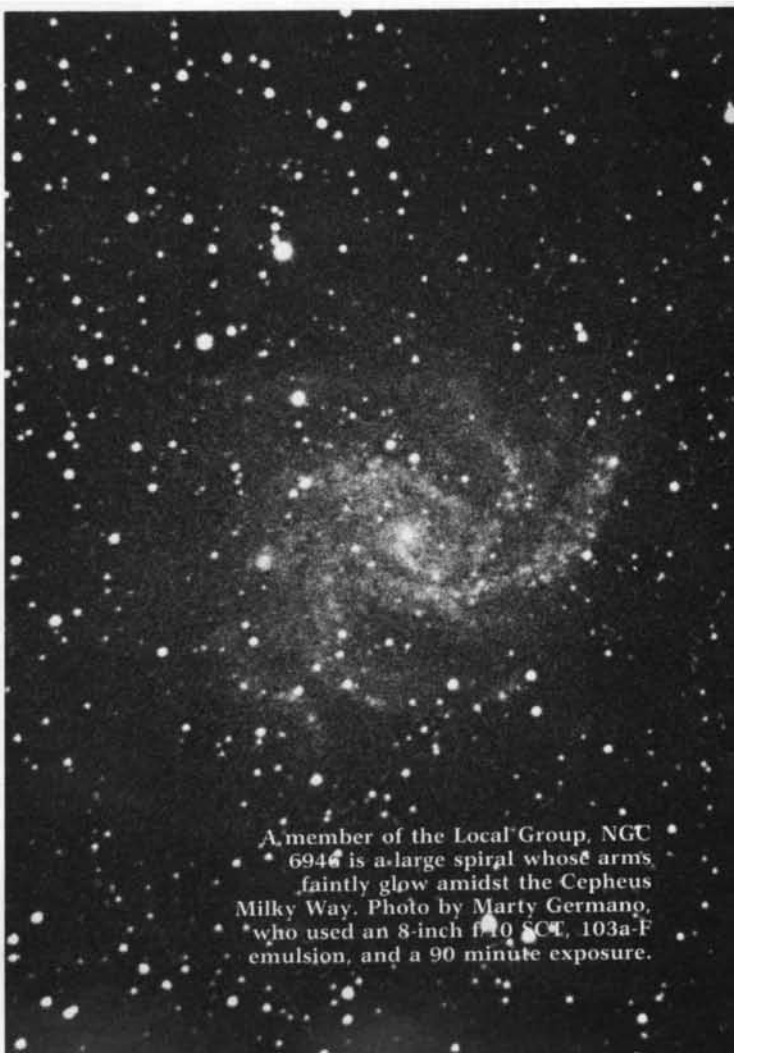
• WITH A SMALL TELESCOPE •

by Richard P. Wilds

In this age of Dobsonian technology and readily available Schmidt-Cassegrain telescopes, many observers have moderately large (10-inch to 20-inch) instruments for deep-sky observing. Certainly this is a healthy development, since it allows more viewers to see more "image" when they gaze at galaxies and nebulae. But what about those of you who drag out your treasured 2-inch refractor or 6-inch reflector? Though not "in vogue" at present, thses scopes still show quite a lot of deep-sky targets — many more than most observers seem to think.

It's important to consider how best to observe different types of objects with a small telescope. After all, you'll be working with limited light-gathering power and magnification. You should have at least one high-quality low power eyepiece: there are several good Kellners and Plossls on the market. It is better to get a single good eyepiece — one that may even cost a healthy fraction of what the scope cost — than to be constantly frustrated because of poor viewing caused by

Globular cluster M13 is one of the most observed deep-sky objects. But a lesser-known treat awaits observers just outside a low-power field: the spiral galaxy NGC 6207. Jack Marling made this photo using a 10-inch f/5 scope, hypered TP 2415, and a 15 minute exposure.



A member of the Local Group, NGC 6946 is a large spiral whose arms faintly glow amidst the Cepheus Milky Way. Photo by Marty Germano, who used an 8-inch f/10 SCT, 103a-F emulsion, and a 90 minute exposure.

cheap eyepieces. Later you can expand your collection by getting a Barlow or other lenses; remember that if you get a Barlow lens you'll keep good eye relief even at higher powers, but they can be expensive. You should locate objects using low powers, and only "crank up" to higher powers if the seeing permits. Techniques like field sweeping (scanning from side to side) and averted vision (glancing with the "edge" of your eye) greatly help small scope observers, so once you've found an object don't be afraid to experiment with technique to secure the best possible view. And note that the critical factor — as far as the objects themselves are concerned — is *surface brightness*, not integrated magnitude. Don't be fooled: galaxy M33 shines at 6th magnitude but is harder to observe than 9th magnitude NGC 6543, because it is so spread out. With a wide-field small aperture scope at a good site, you'll be surpirised at the things you can observe.

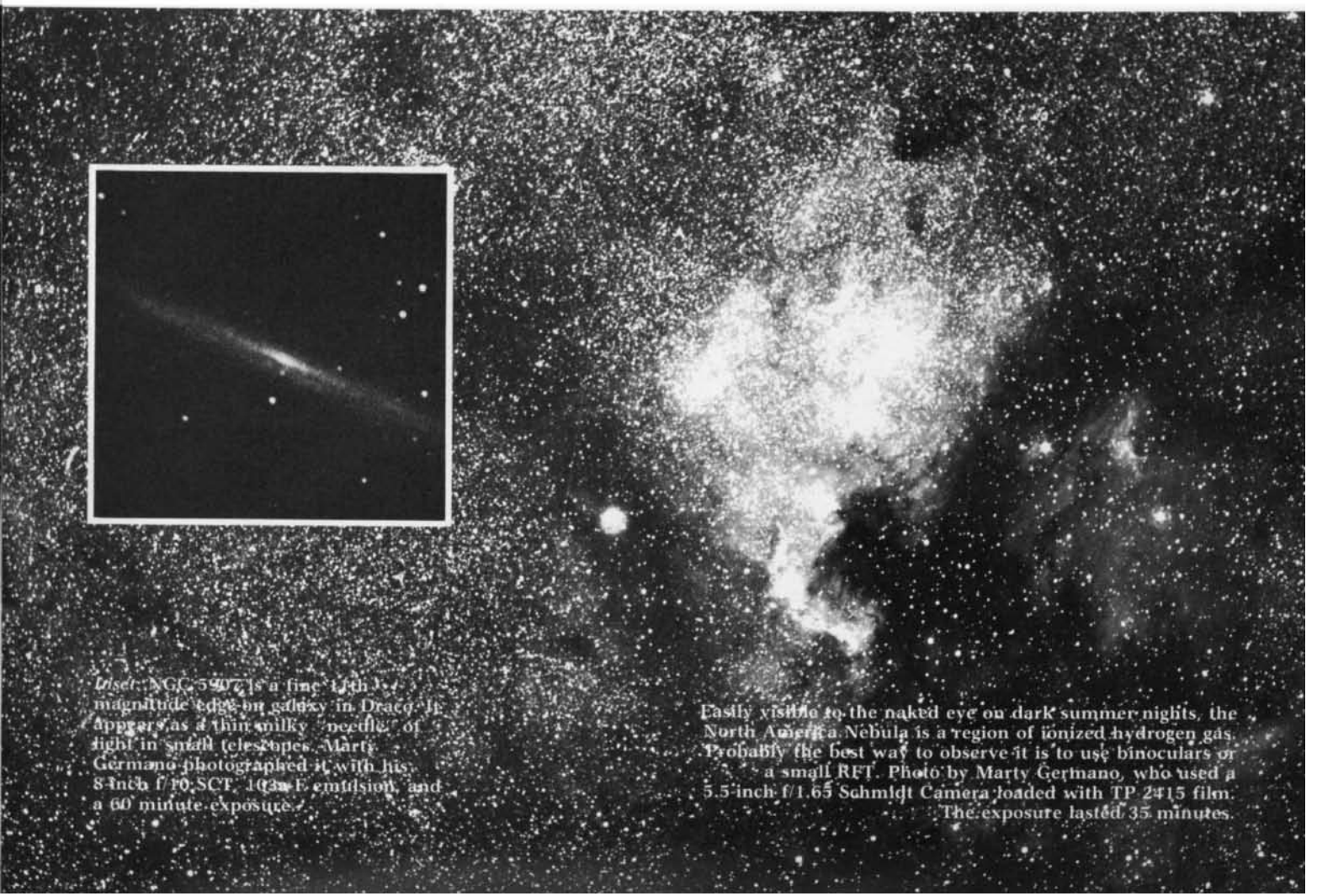
An interesting circumpolar object is **NGC 6543**, a planetary nebula in Draco. Small telescopes traditionally don't do well with tiny planetaries: at low power the ball of gas appears as a 9th magnitude star, but with more magnification you'll see the fuzzy oval shape that gives it away. With my 2-inch f/12 refractor, NGC 6543 took on shape at 50x, but I found that it looks better at around 100x. At this power the north-south elongated patch looked similar to Pat Brennan's drawing in the Webb Society's *Observer's Handbook, Volume II*.

Another interesting object in Draco is **UX Draconis**, an RR Cor Bor type variable that fluctuates between 6th and 7th magnitude every 170 days. UX Dra is very reddish — it has a spectral classification of N — and is also known as **Birmingham 607**. Since you will be looking at UX Draco you might as well star-hop over to the northern crown to take a look at the class namesake. **RR Coronae Borealis** varies from approximately magnitude 7 to 8.5 over 60 days, and as an M spectral class member it should prove to be more orange than red. Take a look for yourself and let me know what you think about their color.

Slightly more demanding are two more red variables from the same constellations. **T Draconis** and **V Coronae Borealis** are both Mira-type variables. Mira, the namesake of this group, is the famous Omicron Ceti which is due to peak in brightness during mid-June this year. Characteristic of the Mira-class stars is that they vary from being faint to a much greater luminosity, and then fade once again into obscurity over periods that average around a year. T Dra varies from 7th to 13th magnitude over 421 days while V Cor Bor changes from 7th to 12th magnitude over 358 days. Both are spectrally classed as N stars, and if you can catch them at or around maximum light they are beautiful.

Also in Draco is a fine 11th magnitude edge-on galaxy, **NGC 5907**. Although its apparent size is listed at 11'x0.6', I think its appearance rivals that of larger edge-on galaxies such as NGC 891, NGC 4565, and NGC 3628. Through my 2-inch NGC 5907 appeared as a bright, long, narrow object, and I suspected — under excellent conditions — a dark lane. Several faint stars are scattered throughout the immediate area, and I noticed a bright patch within the western arm that could have been a star. While in the area, you might also take a look at M102 (NGC 5866), since it makes for a pretty view with stars involved. This is one of the "missing Messier objects:" Messier probably duplicated seeing M101 for his 102nd entry, but many observers accept NGC 5866 as a substitute for the bookkeeping goof.

Moving on to Hercules, **NGC 6207** is a 12th magnitude far-away spiral that lies very close to globular M13. Taking your eye off the chains of faint stars eminating from the giant globular, you'll notice two bright stars on either side of the cluster. From the northeastern star, move north for a distance equal of that between the star and the cluster. My 2-inch f/12



Inset: NGC 5907 is a fine 11th magnitude edge-on galaxy in Draco. It appears as a thin milky "needle" of light in small telescopes. Marty Germano photographed it with his 8-inch f/10 SCT, 103a-E emulsion, and a 60 minute exposure.

Easily visible to the naked eye on dark summer nights, the North America Nebula is a region of ionized hydrogen gas. Probably the best way to observe it is to use binoculars or a small RFT. Photo by Marty Germano, who used a 5.5-inch f/1.65 Schmidt Camera loaded with TP 2415 film. The exposure lasted 35 minutes.

scope revealed a faint oval about 2' in diameter and a delicate double star directly to the east. The view isn't spectacular, but impressive for a $50 telescope!

What objects do you think of when making an observing list for a star party? Probably not among them is **NGC 6800**, a little-known open cluster in Vulpecula that is a perfect object for comparing the views through different telescopes. The group contains 25 stars of 10th magnitude and fainter in a 15′ area. On the *Falkau Atlas* by Hans Vehrenberg the cluster appears as a curiously round and empty circle of stars. It's interesting to note that Vehrenberg took the Falkau plates with a small lens, and the best views of this circular cluster result from using small scopes. Large scopes tend to bring in fainter stars, softening the "contrast" of the bright cluster members, and taking the edge off the circle's perfection. Look for NGC 6800 just half a degree to the northwest of 6 Vulpeculae.

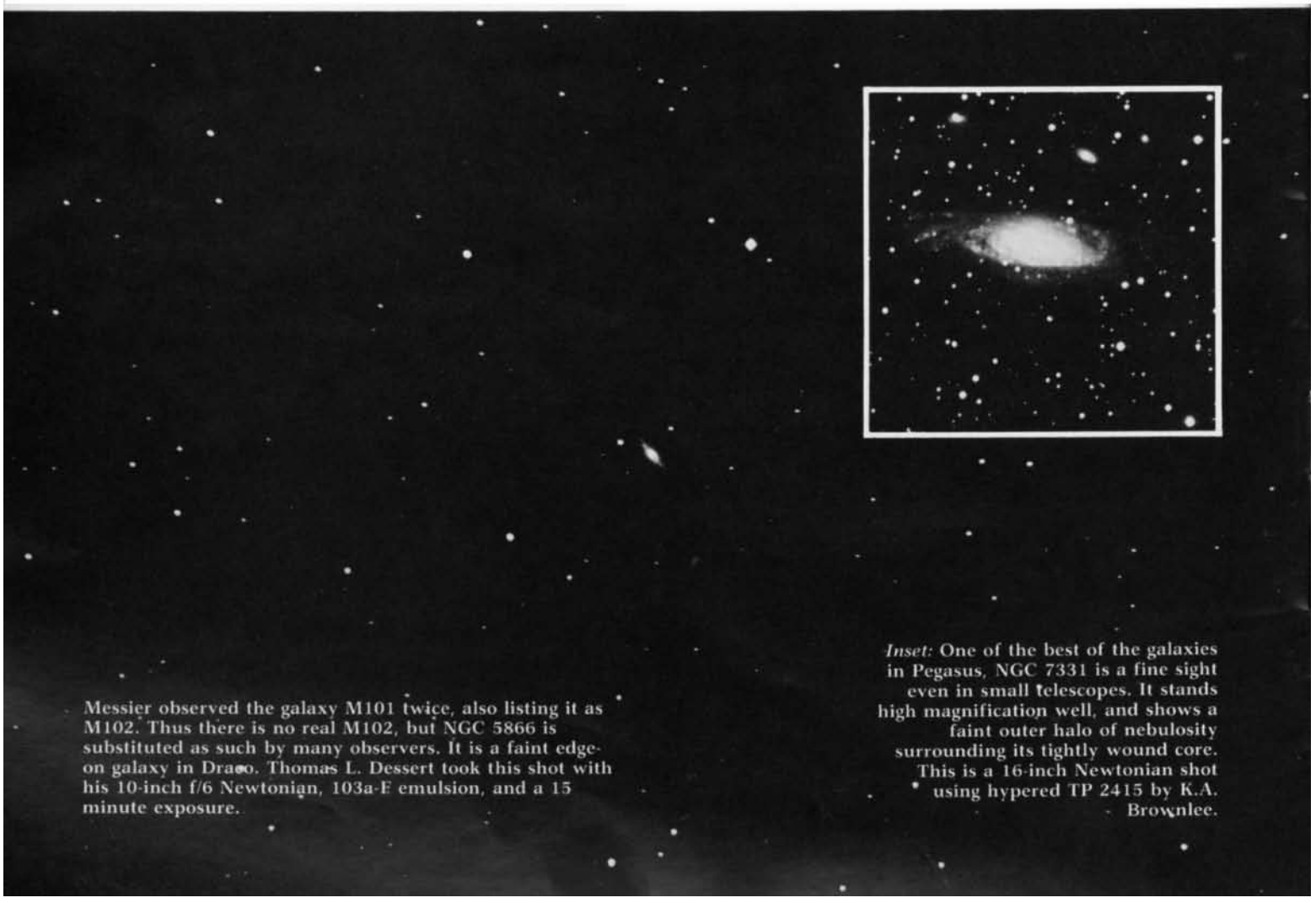
The next two objects are nebulae, one best seen with the naked eye and the other with binoculars. The naked-eye object is a huge dark nebula which includes **Barnard 150**. This rift in our Galaxy begins in the dark spike visible just northeast of Deneb, Alpha (α) Cygni, jets upward through stars Alpha (α) and Eta (η) Cephei, and through the faint reflection nebula NGC 7023, which itself measures 18′ across and is faintly visible in small scopes. It then narrows at Beta (β) Cephei, curves somewhat east-northeast, and finally ends up between the variable S Cephei and the stars 28 and Rho (ϱ) Cephei. The binocular object is **NGC 7000**: observers have long known about the *North America Nebula* and its huge apparent size. To view it, you'll need an extremely wide field eyepiece in an RFT or binoculars. On very dark nights you can see it with your naked eye as well. While there you might also take a look at the fainter *Pelican Nebula* to the west, and the beautiful red star Xi (ξ) Cygni to the east.

Just 1° west of Barnard 150 is the 9th magnitude Sc galaxy **NGC 6946**. Through my 2-inch refractor this object spans 8′ across, appears oval, and lies in a fine field that includes the open cluster **NGC 6939**. The cluster also measures 8′ in diameter, and contains 100 stars between magnitudes 12 and 16. Through my 6-inch f/6 reflector the galaxy expands into an interesting object with hazy extensions protruding outward. At what aperture does this object appear interesting to you? Jumping straight across the Galactic center we will find galaxy **NGC 7331** in Pegasus, an Sb spiral glowing at 10th magnitude. Through my 2-inch I saw this galaxy as a 10′ x 2′ oval, but unlike 6946, I spotted a stellar nucleus. Two faint stars appear to touch the galaxy's edge.

Taking a big step south into Sagittarius, we can find **M8** (NGC 6523), the *Lagoon Nebula*. This famous region of ionized hydrogen glows at 5th magnitude (including its bright star cluster) and measures over a degree across. This is an object that draws many telescopes: my 2-inch shows a great deal of nebulosity mixed among the stars of the cluster, **NGC 6530**. Many references claim that the dust lane, or "lagoon," is difficult to observe with anything less than a 6-inch scope. I've always observed it with any telescope I've had, including the 2-inch. Look for detail in complex objects like M8 — how many stars are involved? What shape is the nebulosity? What color is it?

Leaving northern Sagittarius, let's journey toward the dimmer area of Ophiuchus. Here lies another dark nebula, **Barnard 103**, located on the western side of the Scutum starcloud. Go out and look at the cloud with binoculars: B103 appears to "cut off" a portion of the cloud, creating a vacancy or hole.

Yet another example of a dark nebula is the little-known **Lynds ID. # 141**. Beverly T. Lynds published her "Catalog of Dark Nebulae" in the *Astrophysical Journal Supplement Series* in 1962. Based on the *Palomar Sky Survey*, her work comprises the most comprehensive catalogue of dark



Messier observed the galaxy M101 twice, also listing it as M102. Thus there is no real M102, but NGC 5866 is substituted as such by many observers. It is a faint edge-on galaxy in Draco. Thomas L. Dessert took this shot with his 10-inch f/6 Newtonian, 103a-E emulsion, and a 15 minute exposure.

Inset: One of the best of the galaxies in Pegasus, NGC 7331 is a fine sight even in small telescopes. It stands high magnification well, and shows a faint outer halo of nebulosity surrounding its tightly wound core. This is a 16-inch Newtonian shot using hypered TP 2415 by K.A. Brownlee.

nebulae. She includes an observability scale of 1 to 6: a "1" is rather difficult to observe, and a "6" rather easy. Barnard 103, for example, has a rating of 6: this means that if the Milky Way background is of average brightness the dark nebula should be easily visible. Her catalog contains a list of numbered nebulae and a second list of ID numbers, representative of groups of associated individual nebulae.

ID.# 141 is a group of Lynds objects filling about 12 to 16 square degrees of sky. If you observe from a very dark site, you'll be able to see it with the naked eye as a large "hole" in our Galaxy. Since the Lynds ratings range from 1 to 6 in different areas of ID.# 141, the binocular view is one of swiss cheese. As I went through this area I had the distinct impression that I saw clouds of nebulosity faintly lit by some distant unknown star.

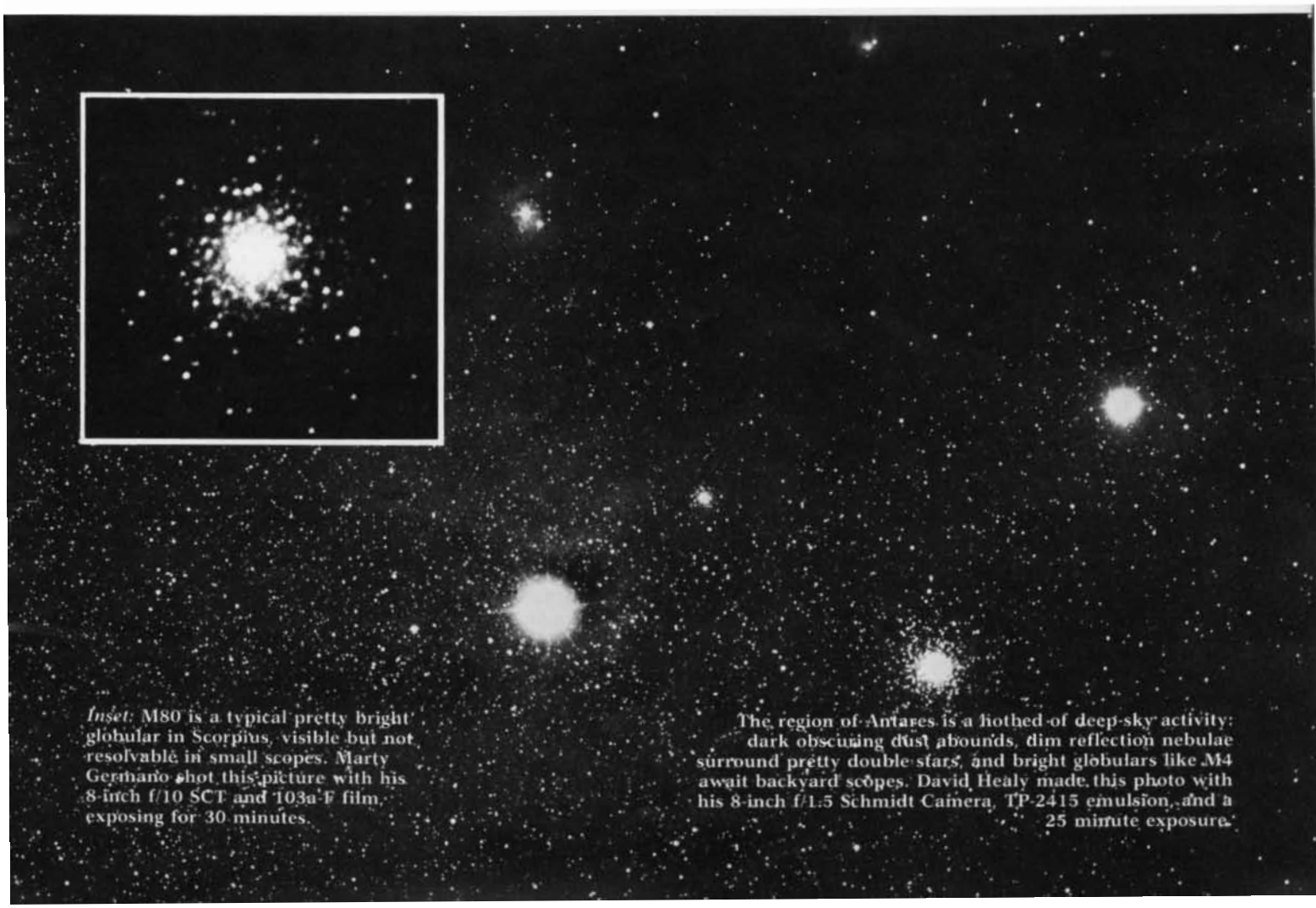
Another interesting summer galaxy is **NGC 6822**, a low surface brightness object discovered by E.E. Barnard with a 6-inch refractor. Many writers claim that because of its low surface brightness the galaxy is invisible in anything less than 8-inch scopes. I wonder what Barnard would have said! In fact, Heber Curtis remarked that NGC 6822 is hardly visible at all in the 100-inch telescope on Mt. Wilson, and that only in a small scope does it show up well because of contrast. The object shines at 11th magnitude but is spread over a 20′ x 10′ area. My 2-inch refractor with a 40mm Kellner ocular shows this faint patch under excellent conditions. Transparency greatly affects its visibility: it presents two "layers" of brightness — a bright inner region and a fainter outer region. On good nights it actually looks like a typical inclined spiral. But under slightly hampered conditions, the faint outer region disappears and the inner region distorts, leaving an irregular blob. Nearby lies the small planetary nebula **NGC 6818**, a 10th magnitude disk measuring 22″ x 15″, which requires higher magnifications.

The planetary nebula **NGC 7293** — the *Helical Nebula* — is the largest such object in the sky. But its huge size of 12′ x 15′ makes its 6th magnitude glow appear faint, and it is difficult to observe. In my small scopes, the nebula appears as a faint roundish object half the diameter of the Full Moon. I did not see the central "hole."

Going south, we come to two more globular clusters in Scorpius. **M4** (NGC 6121) and **M80** (NGC 6093) are both nice objects, and the larger brighter M4 (just west of Antares) is well known for its easy resolvability. Once you've found these clusters use medium to high powers for the best view. M4 measures over 20′ across and radiates at magnitude 7, making M80's statistics of a 7′ diameter and 8th magnitude unimpressive by comparison. But they are both good objects. These two clusters lie right on the edge of the Rho (ρ) Ophiuchi region of nebulosity. In contradiction to the modern idea that dark nebulae affect star counts, William Herschel believed that the clusters swept up stars from the region.

There are many objects visible in the summer skies for you and your small telescope. If you can observe from a dark site, you'll be surprised at what your small aperture can "pull in." Traditionally authors underestimate the visibility of objects in small scopes. Yet with the right practice, sky transparency, and observing technique you *can* see objects like the Veil Nebula with — yes — a 2-inch refractor. But enough of this preaching — go out and see what your scope can really do. Let DEEP SKY know what you can and can't observe; we'll always publish as much of our readers' observations and thoughts as we possibly can.

Richard P. Wilds teaches emotionally disturbed teenagers at a psychiatric hospital in Topeka, Kansas. He is completing his master's degree on the history of astronomy, and uses small telescopes to observe deep-sky objects from the dark skies of central Kansas.



Inset: M80 is a typical pretty bright globular in Scorpius, visible but not resolvable in small scopes. Marty Germano shot this picture with his 8-inch f/10 SCT and 103a-F film, exposing for 30 minutes.

The region of Antares is a hotbed of deep-sky activity: dark obscuring dust abounds, dim reflection nebulae surround pretty double stars, and bright globulars like M4 await backyard scopes. David Healy made this photo with his 8-inch f/1.5 Schmidt Camera, TP-2415 emulsion, and a 25 minute exposure.

Hunting Planetaries in Aquila

by James E. Meketa

On a clear summer's night you can see the massive central disk of older stars that make up the core of our Galaxy. Centered on the Scorpius-Sagittarius border, it extends across the sky from Cygnus in the north to Carina in the south. Wondering at the soft glow of these countless unresolved suns, ancients named it the *River of Heaven* — we call it the Milky Way.

Virtually all of the 1100 or so known planetary nebulae reside inside this disk, in a thin band within 20° of the galactic equator. Some estimates place the total number of planetaries in our Galaxy at over 50,000 — 98% of which escape our detection through the dimming of interstellar absorption. But our planetary nebula catalogues are not limited just by dust, since time is an important factor as well. The tenuous excited gas that we see when observing a planetary is expanding at about 20 kilometers per second. As a planetary grows, it becomes increasingly dim and rarified, until after perhaps 30,000 years it disappears altogether.

The constellation **Aquila** is located in the middle of the Milky Way, less than 40° from the galactic core, and yet it is surprisingly devoid of deep-sky objects. It holds no Messier objects, and Robert Burnham, Jr. lists only a single page of NGC objects for amateur observers. But while none of them are truly spectacular, Aquila does contain nearly 10% of all known planetary nebulae. Perek and Kohoutek, in their 1967 *Catalogue of Planetary Nebulae* (see a university library), list 85 planetaries within the boundaries of Aquila. At least 14 of these can be found with modest instruments, and the generally excellent finder charts provided by Perek and Kohoutek could make virtually all of them accessible to amateurs with clear skies and large telescopes.

Planetary hunting in Aquila rapidly becomes a challenge once you have spotted the five or six brightest nebulae. Even in a small amateur telescope, the Aquila Milky Way contains such a profusion of faint stars that star-hopping to your target is almost hopeless. Eyepiece fields are a jumble of stellar points, and that neat asterism plotted in the star chart that was going to lead you directly to the next planetary turns out to be completely unrecognizable against the rich background.

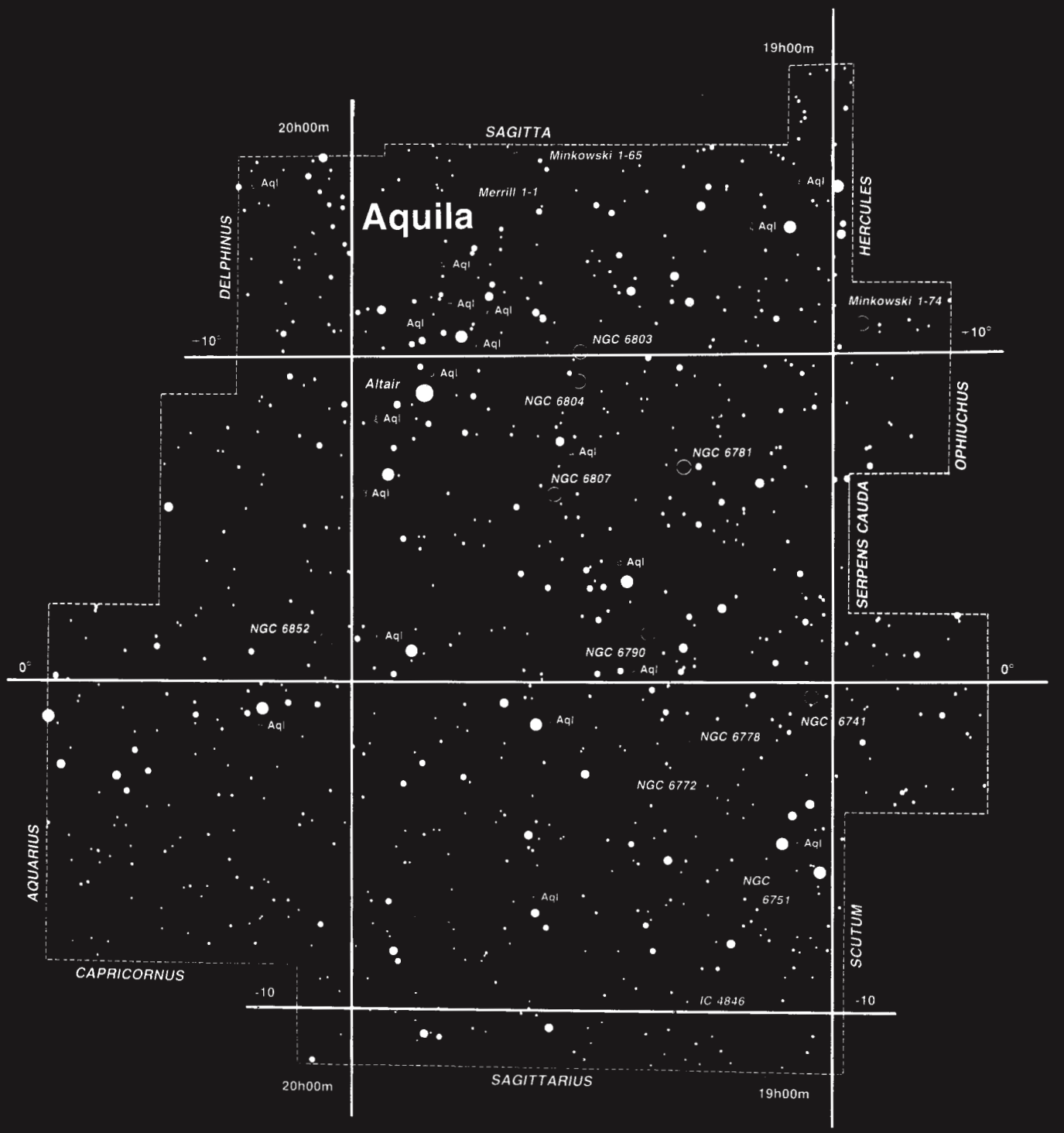
The vast majority of planetaries appear very small or nearly stellar — this sometimes makes them hard to recognize — but because all of their light is concentrated in a small area, they have high surface brightnesses and tend to bear magnification well. After you find the planetaries, always try the highest powers that your optics and the prevailing sky conditions permit. At 200x, many small planetaries look like tiny disks, hardly larger than the seeing disks of surrounding stars. However, these tiny disks give the planetaries a "flat" look compared to nearby stars, just as naked-eye planets do not look at all like comparably bright stars. I find that with averted vision, small planetaries often seem to "blink" in and out of view as I move my eye, whereas stars of equal brightness seem steady.

Another way to spot small faint planetaries is to use a light pollution (LPR) filter. The light from planetaries does not form a continuous spectrum as is the case with stars but rather consists of light from a few discrete frequencies. Over half the visible light of most planetaries is derived from the emissions of doubly ionized oxygen that form the bright green "forbidden" lines at 4959 A and 5007 A. Most of the rest of the light comes from reddish Hα (6562 A) and violet Hγ (4340 A). Thus, reflectors are often an advantage in viewing planetaries because their perfectly achromatic images compress all the available light into a single point. Refractors of 6-inch aperture and larger have so much color that all but the oxygen emissions are lost. With either a reflector or a refractor, a narrow band LPR will reject all light except that centered about the chief planetary emission lines, enhancing the contrast and hence the visibility of the planetary.

Volume 2 of the Webb Society's *Deep Sky Observer's Handbook* contains many other useful tips for viewing planetaries, including instructions for the use of small, direct vision spectroscopes. I would appreciate hearing from others who have had any experience with these devices.

NGC 6781 is the easiest to observe, and also one of the nearest, lying a mere 3000 light years away. In 1830 John Herschel discovered this object, and described it as a "very faint nebula." At first this description seems surprising, since on a dark summer night I find NGC 6781 faint but easy in a 4¼-inch f/4 scope at 27x. The trick is that most modern deep-sky telescopes operate at low focal ratios (f/4 to f/6), providing large exit pupils with ordinary eyepieces. The Herschels could not figure fast mirrors, and hence were forced to observe with very small exit pupils (under 2mm), a distinct disadvantage on large, diffuse objects of low surface brightness such as NGC 6781. (The 12-inch speculum metal reflector with which Herschel made most of his discoveries had a focal ratio of f/20, and the 6-inch he used to discover Uranus was an f/14 instrument.)

Perek and Kohoutek classify NGC 6781 as an irregular disk with traces of ring structure. In my 18-inch f/4.5 it is a very round, soft white ball, a little dimmer and somewhat ragged on the north side, but without any hint of annular (ring) structure. At 2′ apparent diameter, it looks very much like a

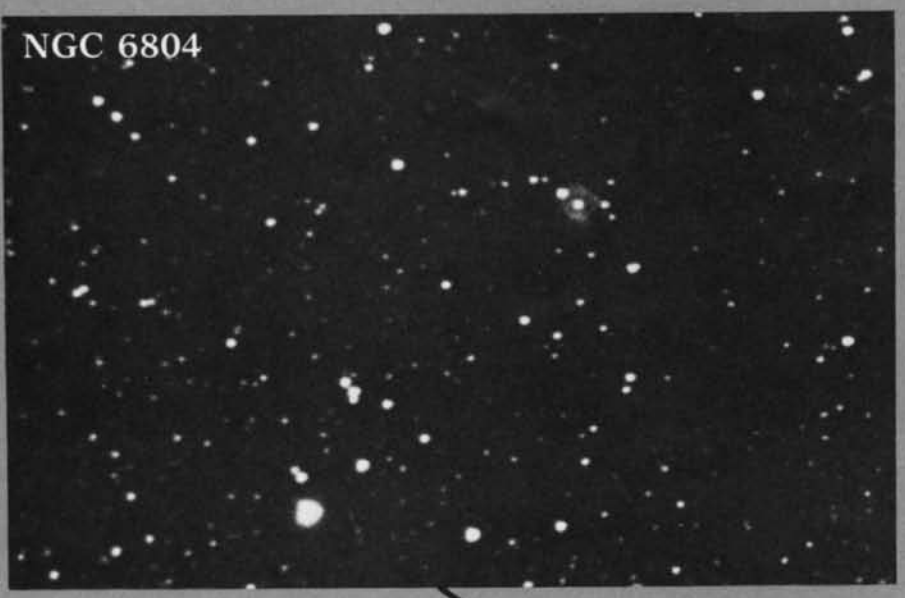


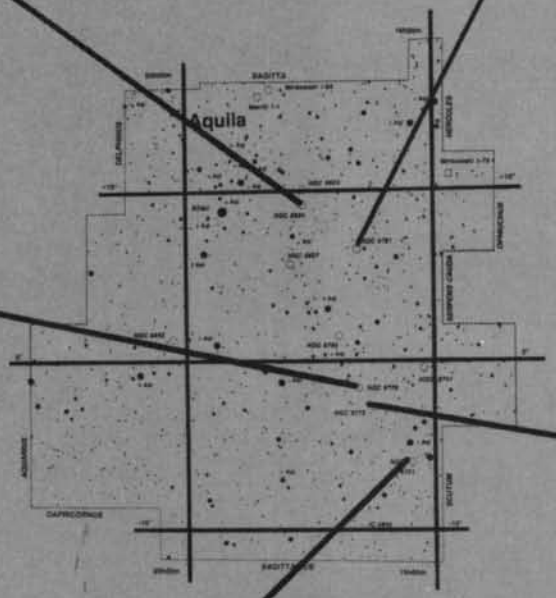
Object	R.A. (1950)	Dec.	Mag.	Mag.*	Size	Sfc.	Discoverer
Minkowski 1-65	18h54.2m	+10°48′	?	?	4″x3″	8	Minkowski (1946)
NGC 6741	19h00.0m	−00°31′	11.2	17	4″	8	Pickering (1885)
NGC 6751	19h03.2m	−06°04′	12.6	13	18″	10.5	Fleming (1907)
NGC 6772	19h12.0m	−02°47′	13.7	18	60″	14	Pickering (1879)
IC 4846	19h13.0m	−09°05′	12.4	16	2″	8.5	Fleming (1901)
NGC 6778	19h15.8m	−01°40′	12.6	15	19″x13″	10.5	Pickering (1882)
NGC 6781	19h16.0m	+06°27′	11.0	14	105″	12	J. Herschel (1830)
NGC 6790	19h20.7m	+01°25′	10.1	10.5	2″	7	Pickering (1882)
NGC 6803	19h28.9m	+09°57′	11.4	14	4″	8	Pickering (1882)
NGC 6804	19h29.2m	+09°07′	12.1	13.5	32″x25″	10.5	Pease (1917)
NGC 6807	19h32.1m	+05°34′	13.8	19	2″	7	Pickering (1882)
Merrill 1-1	19h36.9m	+15°50′	12.6	?	12″	8	Merrill (1942)
Minkowski 1-74	19h40.0m	+15°02′	?	?	9″	8	Minkowski (1946)
NGC 6852	19h58.1m	+01°35′	?	?	27″	?	Kohoutek (1963)

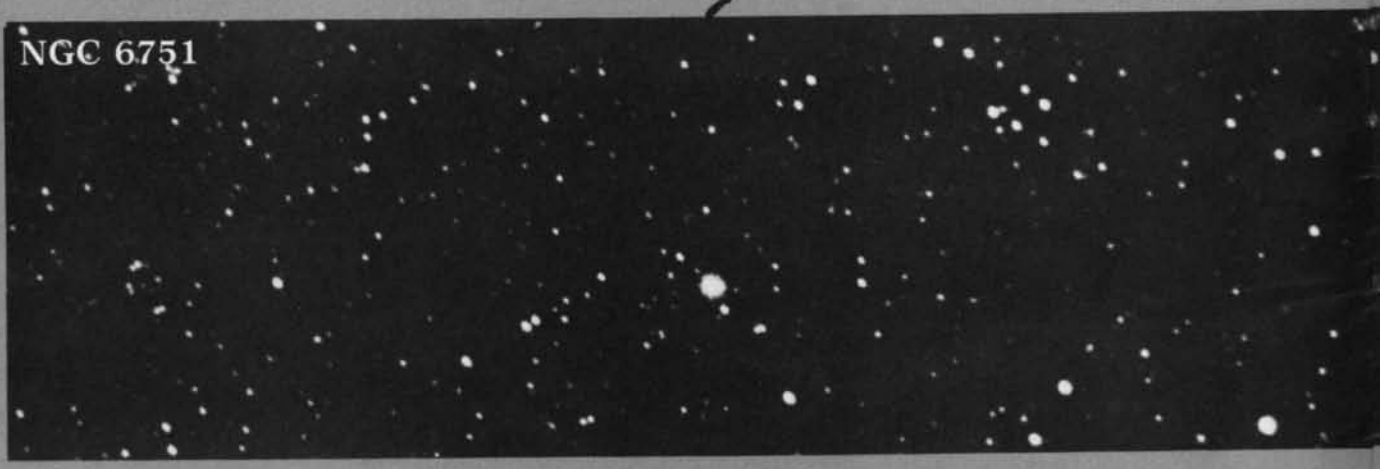
This table lists the 14 brightest planetaries in Aquila. The positions are given in epoch 1950.0. The "size" column lists the nebula's apparent angular diameter in arc seconds, and the magnitude columns provide visual apparent magnitudes of the nebula and its central illuminating star. The last two columns are mean surface brightness and the nebula's discoverer and year of identification.

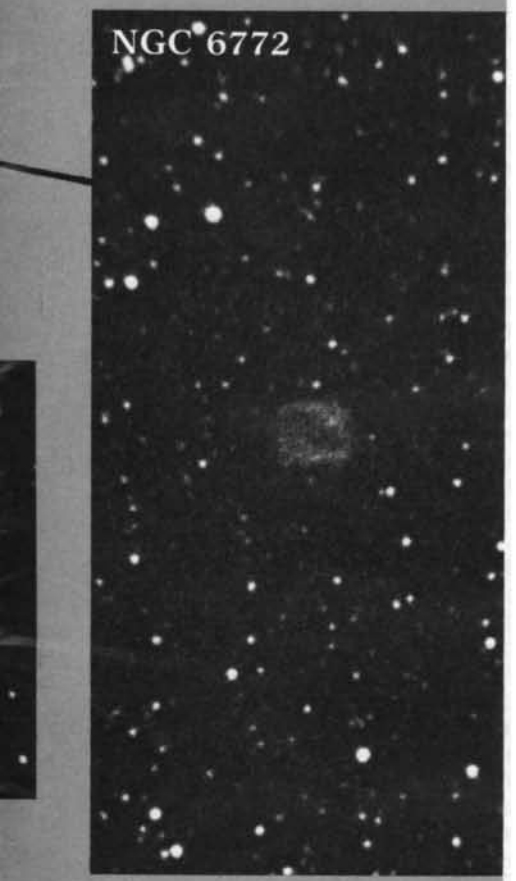
Planetaries in Aquila: Ghostly Puffballs in the Eyepiece

All photos by Marty Germano using an 8-inch SCT.









smaller and fainter version of the Owl Nebula. Under excellent conditions, the 14th magnitude central star is just visible.

NGC 6804 is another large bright planetary, located about 4° northeast of 6781. The Herschels catalogued it as a very compressed and rich cluster of stars, and it was not identified as a planetary until Francis Pease re-examined it in 1917. In my 18-inch it is about 1′ in diameter, white, and of roughly triangular shape. Its edges are ragged, and there are two faint stars on either side nearly in contact, which probably explains the erroneous classification by the Herschels. Under the very dark skies of Fort Davis, Texas, I easily saw the central star using averted vision.

The only planetary in Aquila correctly identified by the Herschels is **NGC 6772**, located about 13° southwest of NGC 6804. NGC 6772 is about the same size and distance as 6804, but I always find it to be a more difficult object. At Fort Davis I had to sweep past several times to locate it in my 18-inch at 129x. It looked very pale, diffuse, and quite round but with ragged edges. With averted vision I saw a hint of internal detail but not surprisingly, the 18th magnitude central star was invisible.

One and a half degrees northeast lies **NGC 6778**. It is twice as distant as the previous objects and appears considerably smaller, about 19″ by 25″ on long exposure photographs. Thus, while its total visual magnitude is only about 12.6, its smaller size makes its average surface brightness much higher than NGC 6772, and therefore I am somewhat surprised it was not found by the Herschels. (Pickering had the honor in 1882.) In large amateur telescopes, NGC 6778 is a classic planetary: small, very round, with no detail or central star.

NGC 6751 is another small but easy planetary overlooked by the Herschels. It is located just to the east of the naked eye fish-hook asterism at the bottom of Aquila (just 3½° due east of M11). I find it about 15″ in diameter and round, with very distinct edges. With the 18-inch at Fort Davis I easily saw the 13th magnitude central star, but I have not seen the star under similar skies with a 12½-inch in Massachusetts. NGC 6751 lies near the center of the Aquila Milky Way, and the background stars are magnificent.

NGC 6741 lies 5½° due north of NGC 6751. With a total visual magnitude of 11.2, it is one of the brightest of the Aquila planetaries, but its small size and the unbelievably rich background make it quite difficult to identify. In my 12½ incher it barely shows a disk at 180x, and I can't discern detail even at 280x. Since the apparent size is only about 4″, you will need excellent seeing to distinguish it from the Milky Way background.

Five degrees east and a little north of NGC 6741 you may find the distant (6.2 kiloparsecs) planetary **NGC 6790**. First identified by Pickering in 1882, this planetary has an integrated visual magnitude of 10.1, but is only about 2″ in diameter. I found it to be fairly bright but extremely small, appearing stellar at any power less than 180x.

NGC 6803 is another stellar planetary, located only 50′ due north of the much larger and easier **NGC 6804**. With a very wide field eyepiece you may be able to hold both NGC 6803 and 6804 in the same field, where they will make an interesting contrast. While both have about the same integrated visual magnitude, NGC 6803 is only 4″ in diameter compared to 30″ for NGC 6804. This difference in size makes NGC 6803 appear at least 2.5 magnitudes brighter than 6804. At Fort Davis I found NGC 6803 to be a small bluish-white disk with sharp edges. The 14.1 magnitude central star was totally lost in the high surface brightness.

The very difficult planetary **NGC 6807** lies 3½° due south of the NGC 6803/6804 pair. At 10 kiloparsecs it is one of the most distant planetaries in Aquila, and appears stellar at every power I've tried. I've only been able to find it using averted vision, causing it to "blink" on and off among the rich field stars.

There is another NGC planetary in Aquila, although it is not plotted on the *Sky Atlas 2000.0* charts, nor is it mentioned by Burnham. **NGC 6852** lies near the eastern edge of the Milky Way, and Perek and Kohoutek classify it as a ring nebula about 27″ in diameter. No magnitudes or other descriptions are given in the standard references, and I have yet to locate it visually. Somewhat surprisingly, Kohoutek claims to have identified it in 1963, but it is clearly noted as a planetary in the *RNGC*. What does it appear to be through your telescope?

Four other planetaries are probably visible in most amateur telescopes. **IC 4846** is plotted and labelled on the *Sky Atlas 2000.0*, and should be visible as a large "star" of about magnitude 12. **Merrill 1-1** is located on the far northern border of Aquila, and appears to be plotted but not labelled on the Sky *Atlas 2000.0*. **Minkowski 1-65** is nearby and **Minkowski 1-74** lies to the west. All three are faint stellar objects.

As a final note, Perek and Kohoutek list 39 little known planetaries, two of which fall within Aquila. At the time they compiled their catalogue, astronomers knew nothing of these objects, save their positions. The two in Aquila are: **P-K 32-8°1** at 19h 19.3m, -4°19′; and **P-K 37-2°1** at 19h 08.1m, +2°45′. Try scanning the indicated locations. Who knows what you may find!

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The Finest Double Stars of Summer

by Glenn F. Chaple, Jr.

To me, summer is a time of mixed blessings. As a teacher, I look forward to summer vacation as a welcome respite from the rigors of lesson plans, piles of exams to correct, and the occasional unruly student. As an amateur astronomer, however, I abhor those lo-o-o-ng twilights that shorten the nights of summer and the haze that often prevails when darkness finally descends.

Still, a hazy summer night can provide the best seeing of the year. The air may not be as transparent as it was in January, but it's often a lot steadier; on July evenings, you have a fair shot at picking out the Cassini division in Saturn's rings with even a small or modest-sized telescope. And now is the time for tackling those tight double stars whose separations approach the theoretical limit of resolution for your telescope's optics.

The summer constellations are chock-full of showpiece double stars, and narrowing the list to a manageable 25 means leaving out some dandies. As with the spring selection in the last issue of DEEP SKY, this list is designed to strike a balance between wide doubles for the small-scope owner and close systems for those who possess larger instruments. Once again, all pairs lie north of −40° declination and this time right ascension ranges between 14h and 20h. Although these stars are fairly bright, you'll still need an atlas (like *Norton's*, the old Skalnate Pleso *Atlas of the Heavens*, or Tirion's *Sky Atlas 2000.0*) to locate them.

Zeta (ζ) Bootis (mags. 4.6 and 4.6; separation 1.1″; position angle 304°, measured in 1983). This close twin system was first seen by William Herschel in 1796. A binary with an extremely eccentric orbit and a period of 123 years, Zeta Bootis is slowly closing to a separation of just 0.03″ by 2021. Now 1.1″ apart, the two white stars provide an ideal resolution test for 4-inch scopes.

Epsilon (ε) Bootis (mags. 2.7 and 5.1; sep. 2.9″; p.a. 338°, 1962). Named Izar, this striking gold and blue combination's colors inspired its discoverer (F.G.W. Struve) to nickname it Pulcherrima — "the most beautiful." The brightness difference between its component stars makes Epsilon Bootis extremely difficult for small scopes. It took numerous attempts before I was able to split the two with a 3-inch reflector. Can any DEEP SKY reader do the trick with an ordinary 2.4-inch refractor?

Alpha^{1,2} ($\alpha^{1,2}$) Librae (mags. 2.9 and 5.3; sep. 231.0″; p.a. 313°, 1913). This is a wide pair, ideal for binoculars or finderscope. But despite the large angular separation, these stars have a common proper motion and are believed to be gravitationally bound.

Xi (ξ) Bootis (mags. 4.8 and 6.9; sep. 7.1″; p.a. 331°, 1982). Xi Boo is a binary system with remarkable yellow and red colors. With a period of almost exactly 150 years, Xi is currently closing up toward a minimum separation of 2.2″ in 2064. It is located about 9° east of Arcturus.

Beta (β) Serpentis (mags. 3.7 and 9.9; sep. 30.6″; p.a. 265°, 1940). If you own a 3-inch or larger scope, you should try your luck looking for Beta's faint companion. Since its position angle is 265° (almost due west), the lesser star will precede the primary as the two drift across the field of view of your eyepiece.

Xi (ξ) Scorpii (mags. 4.8, 5.1, 7.2; seps. 1.1″ and 7.6″; p.a. 18°, 1980 and 53°, 1959). If you want to see all three members of this fine triple system, you'll need at least a 4-inch scope — and don't dawdle too long! The close pair is a fast-moving binary with a period of 45.7 years, which is currently closing toward its minimum separation of 0.3″ in 1997. In the same field of view but 5′ south lies Σ1999 (mags. 7.4 and 8.1; sep. 11.4″; p.a. 100°, 1950).

Beta (β) Scorpii (mags. 2.9 and 5.1; sep. 13.6″; p.a. 24°, 1958). Beta Sco is a renowned and beautiful pair — easy for small telescopes, brilliant in large ones. The primary star is white, while its partner seems blue or blue-green.

Nu (ν) Scorpii (mags. 4.6 and 5.6, 7.0 and 7.7; seps. 1.2″ and 2.3″; p.a. 2° and 51°, 1967). Nu Scorpii is a quadruple system comprised of two close pairs separated by 41″ of arc — a sort of miniature "double-double." This is much more difficult than its better-known counterpart in Lyra; you'll need a 4 to 6-inch telescope, high power, and steady skies. It is located just 1.5° east of Beta Sco.

Sigma (σ) Coronae Borealis (mags. 5.7 and 6.7; sep. 6.6″; p.a. 233°, 1980). This is a binary pair with a period that is uncertain, but probably about 1000 years. The orbital motion is producing a very slow increase in position angle and separation. You'll find it a nice small-telescope sight.

Alpha (α) Scorpii (mags. 1.2 and 6.5; sep. 3.0″; p.a. 275°, 1959). Antares is an extremely difficult pair, one that normally requires at least a 6-inch objective and optimum seeing conditions. Those fortunate enough to spot the companion generally describe it as greenish in color, but this is likely a contrast effect caused by the bright ruddy primary. No orbital motion has yet been detected, although both stars have the same proper motion.

17 Draconis (mags. 5.6 and 6.6; sep. 3.2″; p.a. 109°, 1962). This star forms a wide triple system with 16 Draconis (magnitude 5.2), which is situated 90.3″ away. Fine sight!

Mu (μ) Draconis (mags. 5.8 and 5.8; sep. 1.9″; p.a. 42°, 1980). Mu Draconis is an ideal test object for 2.4-inch refractors; I recommend that you use high powers on it. Although the position angle of this binary is decreasing by over 8° every 5 years, the separation will hold at about 1.9″ for the remainder of this century.

36 Ophiuchi (mags. 5.3 and 5.3; sep. 4.6″; p.a. 155°, 1980). There's something downright inspiring about the sight of these golden yellow twins. They circle at a leisurely pace around their common center of mass, completing an orbit every 5½ centuries. (A third system member, of magnitude 6.7 and located 12′ eastward, is also golden-hued.) Lying at a distance of "only" 18 light-years, 36 Oph is a relative neighbor of ours.

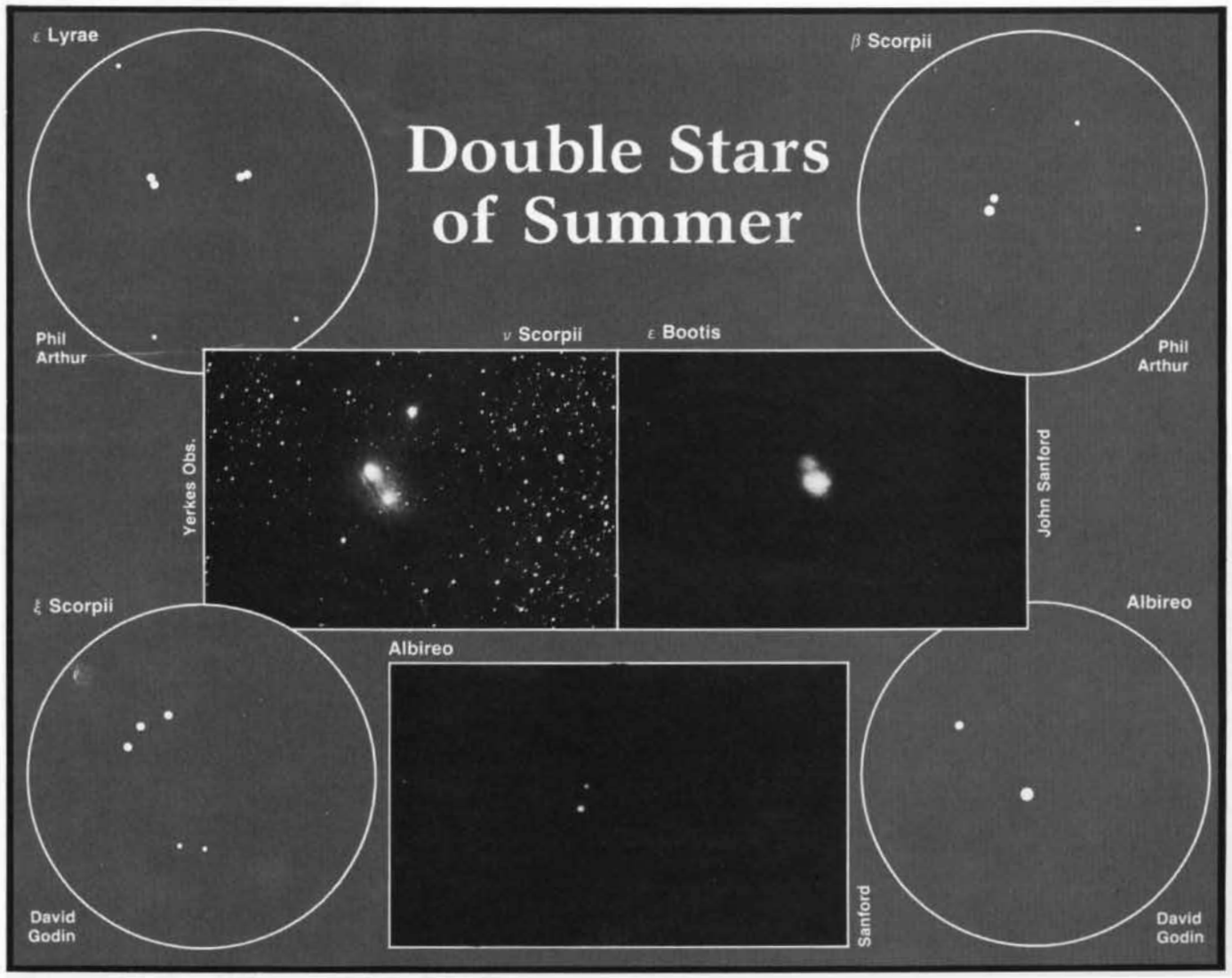
Alpha (α) Herculis (mags. 3.1v and 5.4; sep. 4.9″; p.a. 107°, 1971). Known as Rasalgethi, this duo — with its striking orange and blue-green components — is a favorite of double star enthusiasts. The primary star is a semiregular variable with a period of about 3 months; minimum brightness is around 4th mag.

Delta (δ) Herculis (mags. 3.2 and 8.3; sep. 8.5″; p.a. 250°, 1969). Delta Herc is a classic example of an optical double — two unconnected stars that happen to lie near each other in our line of sight. These "ships passing in the night" were almost 26-arc-seconds apart in 1830 and reached their minimum separation (less than 9″) two decades ago. The fainter star is moving westward at nearly a right angle to the primary, whose proper motion is carrying it southward.

Nu (ν) Draconis (mags. 5.0 and 5.0; sep. 61.0″; p.a. 312°, 1955). The faintest star in the head of Draco, Nu is a grand pair for binoculars and small scopes. Nu, Mu, and 17 Draconis are all conveniently arranged in a row about 8° long, giving you a fine opportunity to make comparisons.

95 Herculis (mags. 5.1 and 5.2; sep. 6.3″; p.a. 258°, 1958). Much controversy exists over the colors of this double, which one 19th century observer called "apple green — cherry red." In 1980, I asked readers of this column to send me their impressions, and the responses indicated that small scopes show little difference if any, while larger instruments revealed colors of pale orange and light blue. Do you agree with these findings?

70 Ophiuchi (mags. 4.3 and 6.0; sep.



2.3″; p.a. 300°, 1983). If you want to study a binary star that combines rapid motion with ease of resolution, this is it. Over the coming decade, the position angle of the companion star will decrease by nearly *120 degrees*! The separation will dwindle to 1.5″ in 1989 (still wide enough for a good 3-inch scope), and will then rapidly increase to nearly 4 seconds by the end of the century. William Herschel gets the credit for finding this pair in 1779.

Alpha (α) Lyrae (mags. 0.0 and 10.0; sep. 62.8″; p.a. 173°, 1946. The challenge with Vega is to pick the faint companion out of the overpowering glare of our brightest summer star. Like Delta Herculis, this is an optical partner, and is now being left behind by Vega's proper motion.

Epsilon^{1,2} ($\varepsilon^{1,2}$) Lyrae (mags. 5.1 and 6.0, 5.1 and 5.4; seps. 2.8″ and 2.2; p.a. 359° and 98°, 1966). Epsilon is the celebrated "double-double." These two pairs — each a slow-moving binary — are 3.5′ apart, a separation that keen-eyed individuals can discern without optical aid. All four stars show in a 2.4-inch refractor at 120x. Can you see a faint pair between ε^1 and ε^2? This is Shj 277, a pair of 12th magnitude stars 45″ apart. Splitting them calls for at least a 4-inch scope.

Σ2375 (mags. 6.2 and 6.6; sep. 2.4″; p.a. 116°, 1966). This binary star system lies in Serpens about 3° northwest of Theta (θ) Serpentis. A delicate little pair, it makes a fair test for a 2-inch scope.

Beta (β) Lyrae (mags. 3.4, 7.8, 9.0, 9.0; seps. 45.7″, 66.9″, 85.5″; p.a. 149°, 1955; 318°, 1929; 19°, 1929). A neat, wide multiple star whose primary is an eclipsing binary that varies a full magnitude over a 12.9-day period, Beta forms an attractive Y-shaped group. (All but the 9th magnitude star at 66.9″ separation are gravitationally bound.)

Theta (θ) Serpentis (mags. 4.5 and 5.4; sep. 22.2″; p.a. 104°, 1955). Theta is the tip of the Serpent's tail. A superb small-telescope pair, both the components shine white.

Gamma (γ) Coronae Australis (mags. 5.0 and 5.1; sep. 1.5″; p.a. 157°, 1980). Gamma CrA is a binary system with a period of 120 years. Currently an ideal 3-inch test, its far-southern position may pose a problem for observers in northerly latitudes.

Beta (β) Cygni (mags. 3.2 and 5.4; sep. 34.3″; p.a. 54°, 1959). What better way to end our list of summer doubles? Albireo, with its stunning gold and blue suns, is "numero uno" with most double star observers. It's easy to find (Albireo forms the base of the Northern Cross) and can be resolved in any size telescope. Here's the ideal object to show that unbelieving neighbor of yours who wonders why you spend all those hours stargazing.

DOUBLE TAKES: All right, double star aficionados! I said I had to leave some fine summer pairs out of this list — do you have a favorite that I skipped? Let me know and I'll mention it here next time.

In a recent letter veteran double star observer Herman Fast described his encounters with Shj 277 (see Epsilon Lyrae above): "Regarding the faint pair between ε^1 and ε^2 Lyrae, I saw Shj 277 with an 8-inch reflector from my back yard in San Franciso, 'way back in 1950. The smallest telescope I succeeded in seeing the pair with was a 5-inch f/13 reflector in 1960. I used a power of 260x."

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Discover Your Own Variable Star!

by David H. Levy

The sky is filled with thousands of variable stars of enough types, sizes, ages and dispositions to confuse any school teacher. But there is always room for more: just when we least expect it, a variable could "pop" into view. And you might be the first to find it. Here is how to discover your own variable star.

As a first step, go out and observe. While the telescope is adjusting to nighttime temperature, check out the sky. Is it just as you left it last time? A good way to begin any night of observing is to review the familiar constellations and asterisms. Slowly and methodically check each star down to second or third magnitude. In all likelihood, all is well, but you never know: an erupting star — a nova — might be out there waiting to be noticed as a "star out of place."

In 1054 Chinese skywatchers reported a dazzling "guest star" in Taurus. This was much more than an ordinary nova, which usually only involves eruptions in a star's outer layers. This was a supernova outburst, triggered by a major instability and collapse within the star. Since then only two other supernovae have been easily visible from Earth, in 1572 and 1604 — a time when European civilization was just about ready to accept new thoughts on the arrangement and stability of stars in space. Novae, though more frequent and less spectacular, are awesome in their own right.

In August 1975, when I returned with friends from an early dinner, I looked up — quite by habit — and saw what I assumed to be a slow-moving satellite just north of Deneb. The others accepted my explanation and went inside, just as I noted that this particular "satellite" wasn't moving. I stared for another minute, and then I realized what it was. A nova — a 1.6 magnitude nova in Cygnus!

In early September 1978 I happened to be locating two of my favorite variables, SS Cyg and its apparent neighbor, a bright red semi-regular called W Cygni. SS Cyg was down, as I expected, but for the first time I had difficulty identifying the field of W Cyg. At first I thought I was just tired, for I knew the field well. Later it hit me: W Cyg was not the only red star in that field — there was a nova too!

In both thes cases, I was far from the first discoverer. In 1975 hundreds of observers noticed that bright light in Cygnus, and California amateur Ben Mayer unknowingly made a beautiful series of prediscovery photographs. Not one but two amateurs discovered the 1978 nova: Warren Morrison of Ontario, Canada was observing with a small refractor, and Peter Collins found it at almost the same time from Mt. Hopkins, Arizona, using binoculars. Both these AAVSO'ers are meticulous observers whose knowledge of star patterns led them to the discovery — a tribute to what amateur observers can do with modest equipment. Open your closet and remove that small telescope that has been gathering dust instead of starlight all these years!

The AAVSO sponsors a nova search program, in which the nova-prone Milky Way regions are divided into over 100 areas. The search is quite basic. With binoculars or a small telescope, carefully check each star in your area down to sixth magnitude. (Some observers go down to seventh or eighth.) If enough areas are covered, we could keep a pretty good watch on the sky, greatly increasing the chances of picking up a nova.

There is one other aspect of this program that I find appealing. Once an area is assigned to you, it figuratively becomes your piece of celestial property. It must be tended like a garden. Make sure that the stars which populate it each night belong there — with no newcomers present. Get to know it well; one day it may reward you.

And what happens if you think you have spotted something? First, determine its position and brightness as accurately as possible. Second, have an experienced observer confirm it. If he agrees that you really have found something, send a telegram noting the exact position and your estimated magnitude to the Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, Cambridge, Massachusetts 02238.

We began this night by checking the sky and examining your newly assigned search areas. Chances are that you have found nothing unusual, so now it's time for variables.

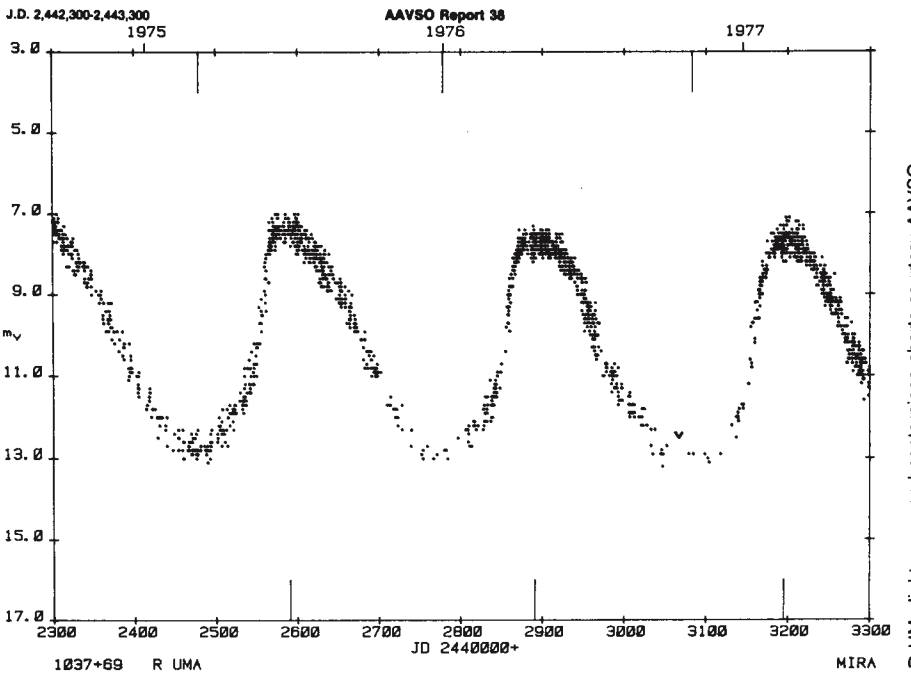
If you didn't find a nova this time out, take a look at an old one — a star that flared to brighter than magnitude 0 on June 8, 1918. It was the second half of what Leslie Peltier dubbed a celestial "double feature" — earlier on its opening day there had been a total eclipse of the Sun!

The star is **V603 Aquilae**, and it can be found with the help of a star atlas. The position of the old nova is clearly marked in *Norton's Star Atlas*.

Go ahead — discover a nova! It probably won't be easy and the process will likely take years. You need to know the arrangement of stars in the sky — those in your search area — as well as you know the rooms in your house. And you've got to be lucky. I cannot tell you when and if you will find a nova. But I can tell you this: if you don't look for one, you'll *never* find it.

Two Stars for a Summer Night

R Scuti is a beginner's paradise. If you look at the charts for this bright summer star, you will likely recognize



R UMa light curve and centerpiece charts courtesy AAVSO

the circle-and-dot that identifies the position and brightness range of the variable. Nearby three other stars are numbered 61, 67, and 71. These represent magnitudes, with the decimal omitted to avoid confusion with a star point. If R Scuti is visible in binoculars, use the "a" chart. (You can order charts for all of these stars from the AAVSO, 187 Concord Ave., Cambridge, MA 02138.) Is R brighter than 6.7 but fainter than 6.1? Say it is precisely between those two stars in brightness; then you record 6.4 as the magnitude. If R is closer to the fainter star, then call it 6.5 or 6.6, and so on. Once you locate R, estimating it should not be difficult. It is the search itself that makes life interesting. And with R Scuti, your search will be rewarded by a free glance at nearby M11.

R Ursae Majoris has a magnitude range of 7.5 to 13.0 and a period of 302 days, making it an excellent target for more advanced observers. With a declination of almost +70 degrees, this Mira-type star is visible all year round from most of the United States and all of Canada. Its field is not overcrowded and its presence near some fairly bright stars makes this star easy to find. Circumpolar stars like R UMa are fun to watch because you don't have a seasonal gap during which you have forgotten most of what you ever knew.

And in the same constellation, we present . . . The Big Dipper Trio! This group of variables is composed of 123961 **S Ursae Majoris** (magnitude range = 7.8 to 11.7, period = 226d); 123160 **T Ursae Majoris** (7.7 to 12.9, 257d); and 123459 **RS Ursae Majoris** (9.0 to 14.3, 260d). Like a an out-of-tune singing group, these three stars seem to perform to the mysterious beat of their own drummer. Each is a long period variable. Notice that the periods of T and nearby RS are only three days off which means that over periods of time they appear to be varying in sync with each other. S UMa, with a somewhat shorter period, appears to be somewhat in discord like the penultimate chord of a Bach fugue.

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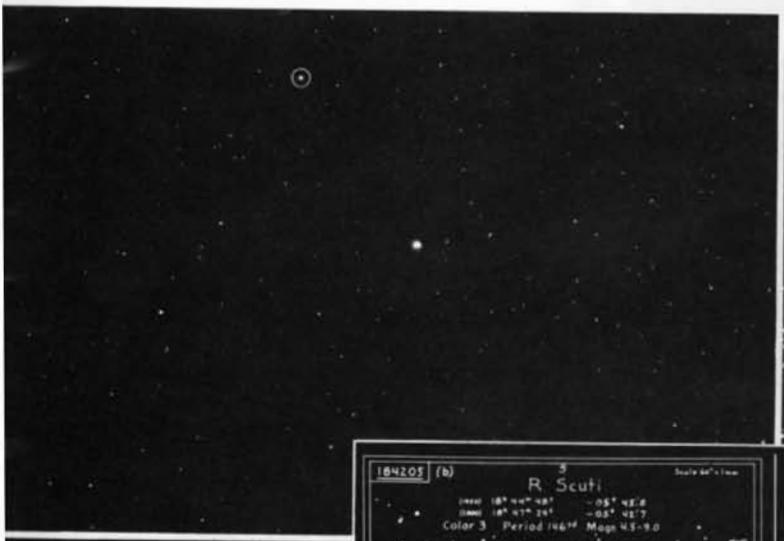
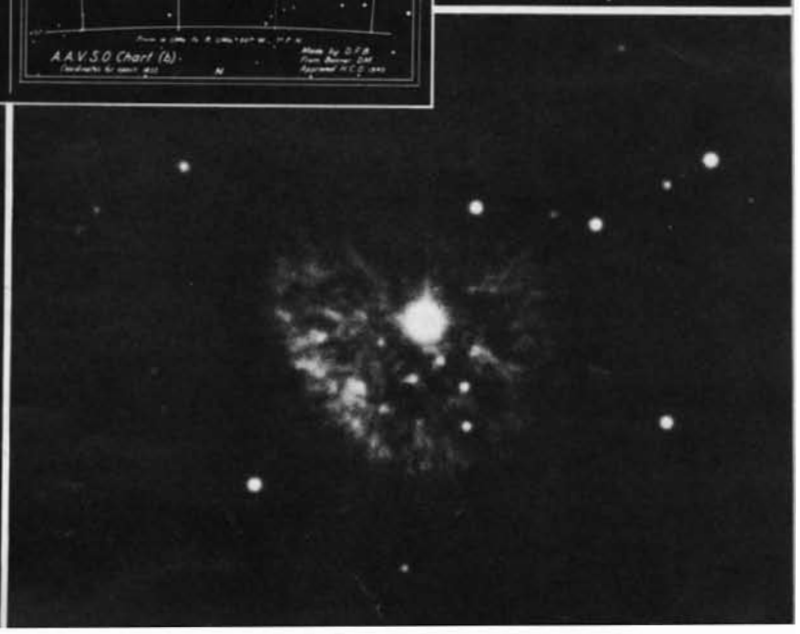


Above: Nova Cygni 1978 peaked at magnitude 6 in the fall of that year. Photo by M. Carolin.
Below: Over 900 years ago the Crab supernova exploded. Today its remains are a favorite object for deep-sky observers. Photo by Al Lilge.

Above: On September 9, 1975, John Riley photographed Nova Cygni 1975. Shining at magnitude 1.8 near the North America Nebula, it became the brightest nova since 1942.
Below: Nova Persei 1901 shone at magnitude 0 for several days. Hale Observatories photo.



A Talk with Dr. Bart Bok

He has now passed his 76th birthday, but his eyes still sparkle behind the lenses, and his gnarled fingers still command a warm handshake. A lifelong investigator of our Milky Way Galaxy, Bart Bok is one of the best-respected, most widely known and most likeable astronomers on this little blue planet. It seem that nothing can stop him — his next international jaunt is to Indonesia for the June solar eclipse — but he has had to learn to set his pace carefully these days, for his heart's sake.

Much of his popularity stems from what he calmly calls "the Book" — *The Milky Way*, published by Harvard University Press and now in its fifth edition. The first four editions were co-authored by his beloved wife, Priscilla, who passed away in 1975. He explains why her name remains as co-author on the fifth edition as well, speaking with deep affection and just a hint of sadness in his voice, "Before she died, she said she would permit her name to stay there on three conditions:

"First, that I would remember the book was written for our children and grandchildren, and that the grandchildren were between 13 and 19. She said the 13 year old may have a little trouble, but by 19, they ought to be able to follow it; that's the level [to aim for]. And the second thing she said was, 'I don't want it enlarged by more than 15 or 20 pages — don't let it become a fat book.'

A last proviso: 'If you want to write a book for the experts in Milky Way research go ahead and do it, but don't put my name on it.' That was very nice. She wasn't interested in difficult technical books — she said this is a book to spread the word about people having a look at the Milky Way."

Bok is very proud of the book and where it has been over the years: "I wanted to write the text with great care. Even a single sentence in the book ought to carry weight — for by now, *The Milky Way* has become sort of a reference work for a number of people. First of all, it's a very good book for bright young people in high school and secondary school. They can work through it and understand it — our grandchildren all did. It's also a very good book for amateurs, who can read it, too. And it is a very good book for people who like to go to planetariums.

David H. Levy

"The Milky Way" has become the book which any physicist, suddenly interested in say, X-ray astronomy, goes to and reads to get an idea of what the hell the Milky Way is all about.

"Then it has two other functions. It has become one of the most popular reference books for beginning courses and even some special advanced courses. And finally, it has become the book which any physicist, suddenly interested in, say, X-ray astronomy, goes to and reads to get an overview of what the hell the Milky Way is all about. I have kept it tightly limited to the Milky Way itself — I feel there ought to be comparable books for other fields."

Asking Bart Bok a question tends to unleash an avalanche of words. One after another, his ideas tumble out — fascinating, informative, often controversial. He is a captivating reconteur who will squeeze an anecdote from his wide experiences into most answers.

I wanted to hear his views on the future of astronomy, one of Bart Bok's favorite topics. He said, "The Space Telescope, I feel very, very strongly, will help out our research on the Milky Way in a very big way: it will bring into view faint objects, and distant ones, and will help unravel the Galactic center. It will do this both by shifting wavelength intervals and, for the most part, by using the instrument's high pointing accuracy and high precision. The whole thing looks unbelievably straightforward. Once you have the pointing accuracy and the resolution, you're in business. The Space Telescope is going to change the whole picture."

But what will happen to the rest of the astronomers?

"There's a lot of support work to be done," he answered, "and, at least initially, one will not do from space anything that cannot be done from Earth. Also, to begin with, there'll be only one Space Telescope, and the time on that will be very heavily subscribed. With just a single Space Telescope, you cannot do too much yet.

"The telescopes on Earth will "feed" the big one, but still there are very good things, like variable star observing, where smaller telescopes come in very handy. Our 36-inch at Kitt Peak, for instance, has a lot of work."

Will all the ground-based optical instruments only feed the Space Telescope?

Bok replies, "The future of ground-based astronomy is fine, but it is not going to produce basic or fundamental discoveries. Take, for example, the 72-inch at Victoria [B.C.]. That has been

"The Space Telescope, I feel very, very strongly, will help out our research on the Milky Way in a very big way: it will bring into view faint objects, and distant ones, and help unravel the Galactic center."

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a very useful instrument, but it's now a supporting telescope. Or take the beautiful telescope in Hawaii — it will be one of the most interesting and useful support telescopes 15 or 20 years from now. They will all become good support instruments: they will be used effectively and they will test equipment. I expect to see the big ground-based instruments become to the Space Telescope what the smaller scopes have been to the big ones up to now.

"But the long-range future of astronomy is in space. If you fly at 40,000 feet and look down, you see all this trembling from the atmosphere. That's no place to put a telescope. You need to take it upstairs, above the whole atmosphere. This fact is just so straightforward and self-evident there's no point in arguing about it. I gave a lecture on cosmology a few years ago at the Americn Academy of Sciences and one fellow got up at the end and said 'Dr. Bok, what should us theoreticians do in the meantime while all these uncertainties come in?' And I told him — well, why don't you sharpen your pencils, so that you're ready when the Space Telescope data come in."

What will become of the Space Telescope?

"If the first one begins to work out — and that may take ten years to see how it goes — then there will be strong pressure for more, and I tell everybody it's not my business how you're going to finance it! That's for the future; these things always get straightened out. If during the Depression someone had said, there are going to be a lot of large reflectors 50 years from now, everybody would have said, oh, no, we can't afford it! One 200-inch is all we can afford. Well, we now have five 100- to 150-inch reflectors of superb quality operating.

"In some ways the Space Telescope will be simpler, because you program it and then you go to some central lab where you watch and push the buttons and your program takes care to see that all the things get done. The Space Telescope is going to be a people's telescope, a real international one, and very soon. Already, there are parallel plans — an infrared telescope (IRAS) is up. Undoubtedly, there will be a Schmidt telescope coming along soon. It has to come. It may take a few years more or less, but 50 years from now, I'm sure that all the frontier work, the big research, the final data gathering, will be done from space. The important thing about space is that suddenly you put your glasses on and say, 'now we can see what's going on.' You have twentieth of a second of arc resolution!"

And there he sits, relaxing in a light blue Mao suit that Chinese tailors made for him a few years ago. Does he enjoy his retirement?

"I was Director [of Kitt Peak] long enough, so in retirement, I've refused to join any committees. I feel I've done my share. The only one I joined was the board of the Astronomical Society of the Pacific, and that's lots of fun to be involved with. I travel and do lecturing and learn a lot of things, talk with people and keep up my research on dark nebulae, and this means that I have a hell of a good time doing what I'm doing."

A wonderful, rewarding time, in fact — and it rubs off on anyone who comes to know the warm glow of his hospitality. His house in Tucson is a large and comfortable bungalow, with a huge pool in the backyard. There is no shortage of things to keep him busy, and, by stepping out his front door, he can peer into the twilight sky. Even after so many decades of probing the depths of the Milky Way, Bart Bok still relishes a glimpse of Mercury or a friendly look at the other planets as the Sun goes down.

Peter Jedicke
London, Ontario

Don't Let Dew Undo You!

Dewing of optical surfaces has been a constant annoying problem of mine for many years. As an avid deep-sky observer, I have found that the single most aggravating and discouraging problem with observing is dew forming on the optical surfaces of a telescope. How often have you lost the use of a finderscope because its objective fogged over? Or an eyepiece? Even Newtonians aren't always immune because their diagonals mist over. And Schmidt-Cassegrains? Forget it! With all that glass out front, you'll lose the use of your objective even before the finder goes.

Your first line of defense is to make a dew cap — which ideally should extend in front of the outer optical surface by at least two tube-diameters. But although this remedy will delay dewing for an hour or so, dew is going to win the battle eventually — especially if you live in a humid climate like I do.

Some observers set out armed with hair dryers to waft warm dry air over the exposed optical surfaces. These generally do the trick, but light pollution has driven many deep-sky observers to distant locations — and 120 VAC isn't often available. Although you can get dryers that work off a 12 VDC car battery, they just don't provide enough heat to do a satisfactory job.

The only real solution to combating dew is applying a constant gentle heat close to the optical surfaces — dew can't form when you keep the air in the tube or dew cap warmer than its "dew point."

I have a Newtonian and the first step I took toward eliminating the problem was to wire the tube. I cemented two insulated solid-conductor, 16 gauge wires on the inside of the tube running the length of it. One of these was

labeled positive (+), the other negative (−). I then drilled a hole at the bottom of the tube, where I installed a Switchcraft B3M chassis-mount male microphone connector. There are three pins on this connector; the negative wire in the tube was soldered to pin #1, the positive to pin #2, and pin #3 was left unused. I then ran a cable from the car battery, terminating with a Switchcraft A3F female connector. (This cable lives in the car-trunk at all times.) Any type of connector will work, but since this type interlocks, it has proven ideal.

The wires in the telescope run all the way to the front; their purpose is to provide a source of power throughout the length of the tube. Wherever you require power, you strip off the insulation on the main wires, splice in the other wires, and run them over to where the heat is needed.

My first project was to heat the diagonal mirror. This meant installing a 1 watt, 220 ohm resistor inside the diagonal cell. A small wire soldered to one lead of the resistor runs through the back of the cell, down one of the spider vanes to the "+" main wire. Another wire soldered to the other resistor lead goes to the "−" main wire; it makes no difference which end of the resistor attaches to which wire.

Do I hear skeptics muttering about image quality? Let all scoffers take note: as yet I have seen no image impairment whatsoever — even when I use high magnifications, image quality is not affected. And under the most severely humid conditions, dew has never formed on the diagonal. There have been evenings when the outside surface of the telescope was soaking wet, but my diagonal still remained dry.

What about the finder? Its eyepiece? And that of the main scope? On these I use special "heating ropes" sold by Jerryco, Inc. (601 Linden Place, Evanston, IL 60202). These are part number J-1490, and are quite a bargain at $5.50 for four ropes. (If you write them, ask for their catalogue too — it's a hoot.) The ropes consist of nichrome wire covered with a soft fiberglass insulation; each has an impedance of 160 ohms. If you cut them shorter, the impedance lowers which raises the heat. Therefore as you need more "warm," simply shorten the rope. And don't fret over draining the car battery — at 160 ohms, one rope draws only 0.08 amps!

Since nichrome cannot be soldered, you must crimp the lead wires onto each end of the rope. These lead wires can be terminated on the ends with a male mini-plug; as with resistors, polarity is no concern. If you wire and attach several female mini-jacks in the telescope tube, it is a simple matter to plug or unplug the heating ropes at any time.

What about performance? Once again, I have yet to have any fogging and the performance of the eyepieces and finder are superb. The warmth around the finder and main eyepieces not only chases away moisture, but proves most comfortable to the observer on cold evenings.

It's clear that you could also rig up these ropes so as to heat the corrector plate on a Schmidt-Cassegrain or a Maksutov, or the objective of a refractor. Living as I do in Virginia, I've found it necessary to heat even the primary on my Newtonian — and there have been no detrimental effects. Fancying things up a bit, I installed on/off switches for both the diagonal and primary heaters, but due to our damp weather in Norfolk, I have to keep these on almost every evening I observe.

It would be interesting to hear other observers' ideas on the elimination of dew. Very little seems to be written on the subject, perhaps because so many have feared that applying heat near the optics would impair the viewing quality.

In any case, my modifications have proven their worth to me — it's quite enjoyable to concentrate on seeking out those elusive objects and never worry about light loss or ruined definition because of dewing.

Kent Blackwell
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DSM Reviews

Webb Society Deep Sky Observer's Handbook: Volume 5, Clusters of Galaxies
Edited by Kenneth Glyn Jones
Enslow Publishers, 1982
xiv + 241 pages; paper, $16.95

The observable universe has been exponentially expanding for the past 18 generations, at the staggering rate of one order of magnitude each generation. It is easy for us to forget that when Galileo first observed the moons of Jupiter in 1609, the known universe was confined to the surface of a sphere only 8000 miles in diameter. Today, just 374 years later, we routinely speak of quasars 5 billion light years distant.

When my grandmother was a little girl, the farthest edge of time and space lay about 100,000 light years away. The discovery of Cepheid variables, telegraphing their distance in simple patterns of period and luminosity, enabled us to extend our depth perception to the edges of our Milky Way galaxy. Astronomers were still cartographers, and their job, like that of the earlier Portugese navigators, was to map the vast new spaces. With eyes and then photographic plates, they compiled the great NGC and IC catalogues, and carefully noted the positions of all bright stars. The universe was obviously huge, but it was still finite and it all made sense — except for the countless nebulous patches curiously shaped like tiny spirals and whorls.

The mystery of these "spiral nebulae" was solved on December 30, 1924, when Edwin Hubble presented his discovery of Cepheid variables in M31 to the thirty-third meeting of the American Astronomical Society. The nebulae were island universes, just as Immanuel Kant had guessed, and they were separated from our own Milky Way by distances that could be measured but not imagined. By 1929, Hubble and Milton Humason had worked out the redshift yardstick, and the universe grew to something on the order of its present size. Eighteen orders of magnitude in eighteen generations.

As Galileo marveled at the moons of Jupiter, his contemporaries were making careful charts of distant lands, rich with spices. Today, George Abell charts distant superclusters of galaxies, rich with giant ellipticals and perhaps massive black holes. These vast aggregations of galaxies, bound by the pull of gravity, fill the heavens isotropically, expanding beyond the limits of detection in every direction. What are these clusters of galaxies? Do they really represent the ultimate pattern, the final format of reality? In his forward to this fifth and last volume of the Webb Society Observer's *Handbooks*, Abell argues "significant but non-conclusive evidence (at this writing) suggests that there are no galaxies, groups, or clusters between superclusters; superclusters thus may well be the most fundamental concentrations of matter in the universe. Moreover, they appear to mark the end of the hierarchy." Well, at least we no longer expect sea monsters at the edge of the world!

Volume 5 of the Webb series is a guidebook to observable clusters of galaxies, an amateur's Baedeker to the largest structures of matter and space yet perceived. Fifty years ago no one knew they existed; today hundreds of amateur astronomers will explore them for pleasure. The book itself is the labor of love essentially by a single man, George S. Whiston, whose name, modestly, does not even appear on the cover.

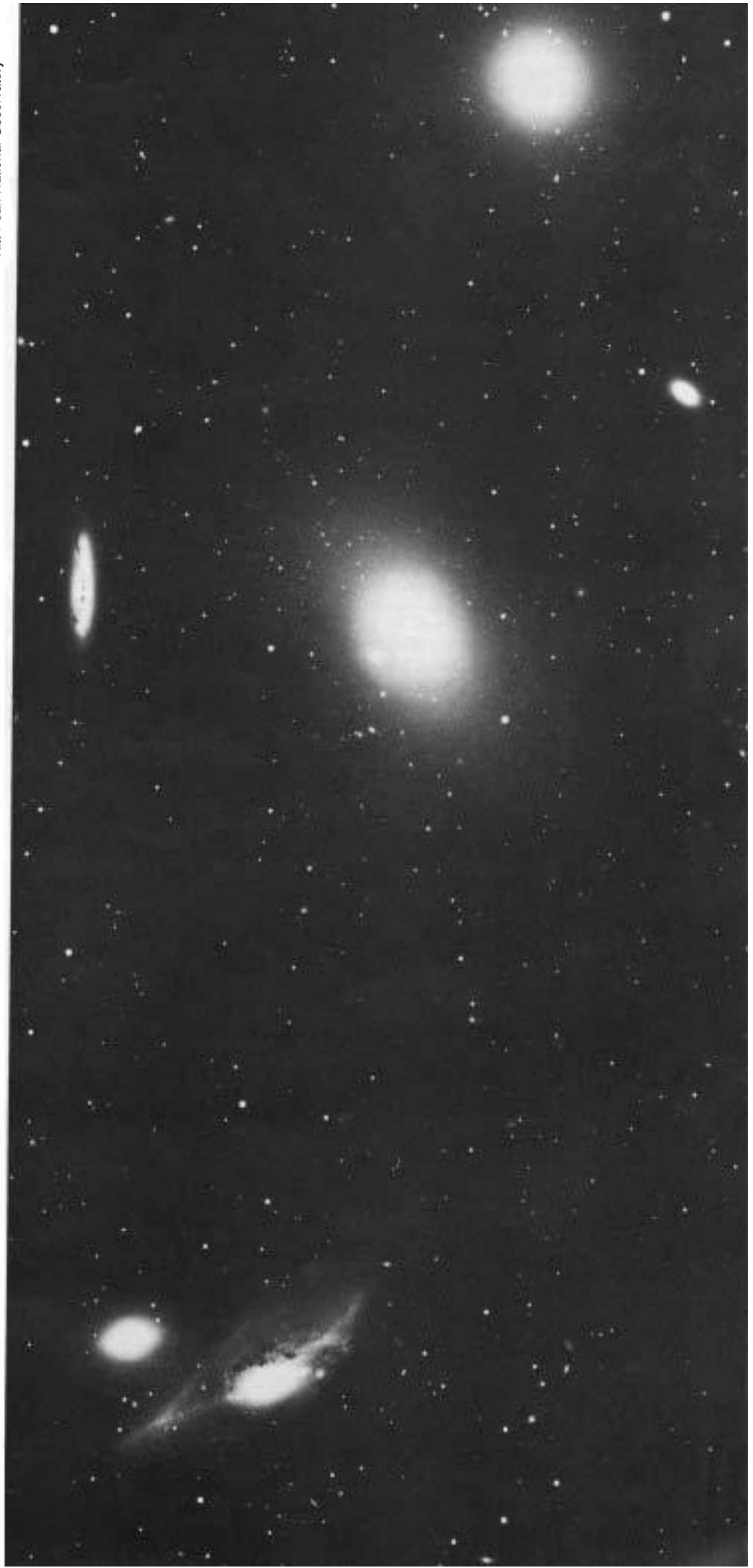
In format and style it is very similar to the preceding four Webb Society volumes, which dealt with double stars, planetary and gaseous nebulae, star clusters, and individual galaxies. It is divided into two sections, the first providing a brief theoretical background to clusters of galaxies, and the second containing the actual listings for observation. I find this dual structure to

be one of the most useful aspects of the Webb Society series. The professional literature of astronomy, like that of all other sciences, has expanded far beyond the grasp of most amateur enthusiasts. By opening each volume with a concise but thorough review of the current theoretical understanding, these handbooks help us to appreciate just what it is we are looking at.

In part one, Whiston takes us through the evidence that clusters of galaxies exist at all. On page 9, he presents the famous Shapley-Ames all-sky map of galaxies brighter than magnitude 13. In addition to the "zone of avoidance" caused by the obscuring dust of the Milky Way, we can easily see what appear to be clumps or groups of galaxies. But are these apparent gatherings real physical associations, or simply circumstance? To answer this question, we must somehow see in three dimensions, a difficult task when the objects of interest are too far away to show any parallax at all. If, however, we believe that the universe is expanding and that redshifts are caused by the consequent recession of all distant objects, then we can begin to calibrate our intergalactic yardstick simply by measuring the spectra of many galaxies. Here we find an unexpected surprise; redshifts seem to come in clumps, too. Thus we have some evidence that galaxies do indeed exist in large, three-dimensional aggregations, with unimaginable voids in between.

Most of the rest of the book's first section is not theory at all, but merely a description of the most recent systems devised for counting and classifying clusters of galaxies. We get the Rood-Sastry scheme, the Bautz-Morgan scheme, and George Abell's own highly statistical model for rich clusters. These schemes are all very primitive, and are likely to be quickly outdated as new observational evidence accumulates. Their value in this book may be to remind the reader that, even with cosmology, much is common-sense.

The second part of the book gets down to amateur observation, and it is here that the enormous effort expended by Whiston becomes evident. Clusters of galaxies exist in most parts of the sky, but all save a few are far too distant and faint to be visible in amateur telescopes. Whiston has gone through all of the professional cluster catalogues, including the Zwicky's 9700 clusters and Abell's 2700 rich clusters, to ferret out 28 that are likely to be of interest to amateurs. For each cluster Whiston first carefully identified each galaxy brighter than magnitude 16 as recorded in the standard references. Most are known only from recent photographs and hence were never assigned NGC or IC numbers. His task was made difficult by the large number of errors and



Kitt Peak National Observatory

The heart of the Virgo Cluster

ambiguities in the reference catalogues, a trap that Whiston himself fell into at times.

The galaxy-lists for each cluster were then compared to *Palomar Sky Survey* prints, from which small- and large-scale finder charts were drawn and labelled by hand. Without these charts, finding your way around any but the most sparse clusters would be absolutely impossible. And finally, Whiston and a handful of other observers made detailed inspections of each of the clusters, using instruments ranging from 20x50 binoculars to a 60-inch reflector. For most of the galaxies observed they recorded brief visual impressions, often based upon observations with scopes of several different apertures, and made careful pencil drawings of the eyepiece field of view. Some of the drawings are spectacular. In one 15′ field centered on the Coma cluster (Abell 1653), Whiston saw 18 separate galaxies in his 16-inch reflector.

Not all of the 28 clusters receive equal treatment. One fourth of the observation section is devoted to the Virgo cluster alone. One hundred and five Virgo cluster galaxies are plotted in the finder chart, and of these 75 have visual descriptions. There are also 42 separate eyepiece drawings made with apertures of 8-inches to 16-inches, showing 61 different galaxies in all. The section on the Virgo cluster is perhaps the most complete tour available to amateurs of this magnificent collection of galaxies. Since most of these galaxies are quite bright — being only some 50 million light years distant — this chapter will be of special interest to amateurs with 6-inch to 10-inch telescopes.

The remainder of the observing section is divided into two parts. The first part presents 15 rich Abell clusters, including the famous Coma and Perseus clusters. Its organization closely follows that of the Virgo cluster section, with galaxy lists, finder charts, and visual observations for each cluster. But here the going gets tougher. The galaxies are much fainter, the finder charts more crowded, and visual descriptions more terse. Eight-inch telescopes are now useless, and most of the observations were made with 16-inch or larger instruments.

The final part of the observation section catalogues 12 galaxy groups. These aggregations are too sparse to qualify as clusters of galaxies, since most have fewer than 10 observable members. However, the galaxies tend to be brighter, many having been included in the *NGC*, and hence are observable by amateurs.

Clearly, a specialized book like this is not going to become a best seller. Since the publisher cannot expect a large return on his investment, there is a natural tendency to cut costs wherever possible; for example, the book was not typeset, but rather was reproduced directly from typed manuscripts. As I read through the book, I found myself constantly annoyed by the poor typography, the lack of spacing between sections, and the poor overall layout of the material. Much or all of this would have been avoided if a little more care had gone into the design of the book.

The book has another flaw, probably related to cost efficiencies: an extraordinary number of typographical errors. In a novel, typos are merely annoying; in a reference work such as this they are confusing at best, frustrating at worst. As an example of the number of typos spread throughout, I found 13 errors in the table of Abell clusters shown on pages 194 through 197.

Despite these faults, I highly recommend Volume 5 of the Webb series. For the amateur interested in observing clusters of galaxies, the sections on the Coma and Virgo clusters alone are worth the price of the book.

Jim Meketa
1029 Beacon St.
Newton Centre, MA 02159

Errors in the Webb Society *Clusters of Galaxies* Book:

1. The declination of cluster 0076 should be +6° 31′.
2. The richness class of cluster 0102 should be 0.
3. The richness class of cluster 0119 should be 1.
4. The declination of cluster 0154 should be +17° 25′.
5. The cluster labelled 0338 is actually 0358 and its declination should be −13° 25′.
6. The richness class of cluster 1225 should be 0.
7. The declination of cluster 1500 should be +74° 40″.
8. The declination of cluster 1991 should be +18° 51′, and its RA should be 14h 52.2m.
9. The declination of cluster 2241 should be +32° 37′.
10. Add the following clusters erroneously omitted from the list:

Abell	AD	R.A. (1950)	Dec.
0014	3,0	00h 12.7m	−24° 10′
0399	3,1	02h 55.2m	+12° 50′
0407	2,0	02h 58.6m	+35° 39′
2247	3,0	16h 51.8m	+81° 40′

Kitt Peak photo

Perseus Cluster

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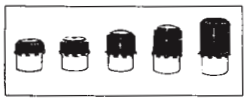

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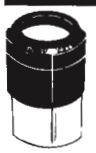

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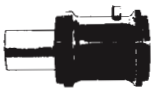

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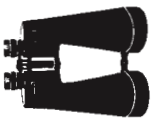

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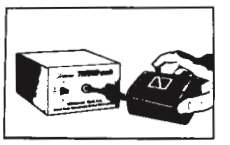

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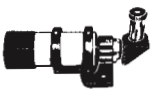

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Scanning the Literature

July — December 1982

The *Publications of the Astronomical Society of the Pacific* contains several articles of interest to deep-sky observers during the latter half of '82. "New UBV Photometry for the Open Cluster Stock 14 and its Cepheid-like Variable V810 Centauri (=HR4511)" by David G. Turner (vol.**94**: page 655, August) presents magnitudes and colors for 35 stars brighter than V magnitude 14 in this sparse southern cluster. The cluster is young (about 6 million years old) and its brighest star is the 5th magnitude variable V810 Centauri. A UK Schmidt photograph identifies the stars measured in the cluster. This is a clearly-written paper including a thorough analysis of the photometric data.

For northern observers, Turner and Douglas Forbes have published another study, "Berkeley 87, A Heavily-Obscured Young Cluster Associated with the ON2 Star-Formation Complex and Containing the WO star Stephenson 3" (**94**: 789, October). Their UBV observations for 105 stars in the vicinity of this cluster in Cygnus (whose brightest stars are magnitude 9) are given along with a photo. The authors combine their data with new and existing spectra and radio observations to show the relationship of the very young cluster (only 1 to 2 million years old) with peculiar stars and with molecular clouds and HII regions in the area. The cluster stars are dimmed by four to six magnitudes and seem to lie on the periphery of a giant molecular cloud. Star formation is probably going on at the site, eating away at the molecular cloud much as the Orion and Lagoon Nebulae are thought to.

Of interest to both visual observers and photographers is "UBVRI Photoelectric Sequences for M83 and NGC 5128" by Douglas B. McElroy and Roberta M. Humphreys (**94**: 828, October). They measured about a dozen stars in the magnitude range 9 to 18 near each galaxy. The V magnitudes and four colors are listed and the stars are identified on nice wide-field photographs.

Double star observers may wish to read "The Evolved Stellar System Σ2367" by A. H. Batten, J. M. Fletcher, W. A. Fisher, Robert D. McClure, C. L. Morbey, R. F. Griffin, and C. D. Scafe (**94**: 860 October). Orbital elements for this triple system are derived including Struve's original discovery 1832 measures. In their summary, the authors conclude: "The system of Σ2367 well illustrates the enduring value of good observations. We have taken great pleasure in using observations that are 150 years old, and, by using them, demonstrating their value for the study of the modern problem of stellar evolution. We hope our observations will prove as useful to those who will observe the next periastron passage [late in the 21st century], when, unfortunately, none of us expects to be in a position to apply for time on ground-based telescopes."

A preliminary study of a faint open cluster is given in "The Distant Open Cluster Tombaugh 2" by David S. Adler and Kenneth A. Janes (**94**: 905, December). (This object was described for visual observers in DEEP SKY 2.) The present paper includes a 4-meter CTIO photo of the cluster and a photoelectric sequence of nearby field stars in the V magnitude range 9.5 to 14.7; the brightest cluster members are about magnitude 15.0. The object is among the oldest of open clusters and lies over 12 kiloparsecs from Earth, or 18.5 kpc from the Galactic center, placing it among the most distant known clusters in the disk of the Galaxy.

Another paper useful to astrophotographers for calibration is "Photoelectric Standards Stars Near V1343 Aquilae (SS 433)" by Elia M. Leibowitz and Haim Mendelson (**94**: 977, December). The authors provide UBV measures for 26 stars close to this unique object (which ranges in magnitude from 11.5 to 16.0). The stars are identified on a photograph.

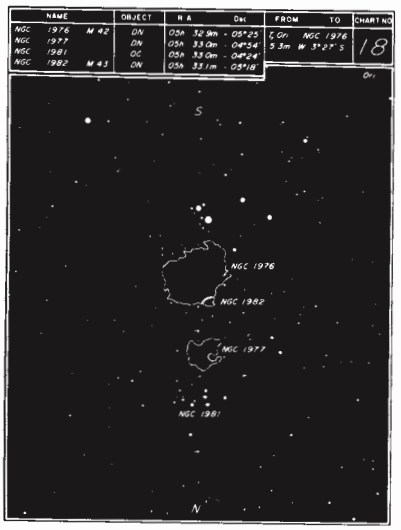
Astrophotographers looking for a tough challenge will want to check out "VLA Observations at 6 and 20 cm of Optical Jet-like Features Associated with the Peculiar Galaxy MCG 5-29-86" by Y. Sofue, Y. Fukui, M. Fujimoto, S. Deguchi, and K. Wakamatsu in the *Astronomical Journal* (**87**: 980, July). The object in question is a strange magnitude 16 galaxy in the same field with NGC 4448, which consists of an oblong core with faint spikes extending from its center. The article includes photos taken with the 48-inch Palomar Schmidt camera and the 4-meter Mayall telescope at Kitt Peak. You can find further observations of the same object in "The Peculiar Disk Galaxy UGC 7576" by Jeremy Mould, Bruce Balick, Greg Bothun, and Marc Aaronson in *Astrophysical Journal Letters* (**260**: L37, September 15). They measure a total V magnitude of about 15.2.

"Further Examples of Companion Galaxies with Discordant Redshifts and Their Spectral Peculiarities" by Halton Arp (*Astrophysical Journal*, **263**: 54, December 1) includes a striking color photograph of NGC 1232 and its Magellanic-type companion, which is shown to have a redshift three times larger than the main galaxy. The main galaxy has a spiral structure very similar to that of the Milky Way as determined from optical and radio observations.

Astrophysical Journal Supplements contains an interesting survey, "The Cluster System of M33" by C. A. Christian and R. A. Schommer (**49**: 405, July). Working from 4-meter Kitt Peak plates, the authors compiled a catalogue of over 250 nonstellar objects in the galaxy. Photometry of about 60 of them serves to make a coarse discrimination among open clusters, globular clusters, and some objects of intermediate class such as the blue populous clusters found in the Magellanic Clouds. They provide large-scale detailed photos identifying the objects in sectors of M33.

Brian Skiff
421 West Aspen
Flagstaff, AZ 86001

SARNA DEEP-SKY ATLAS



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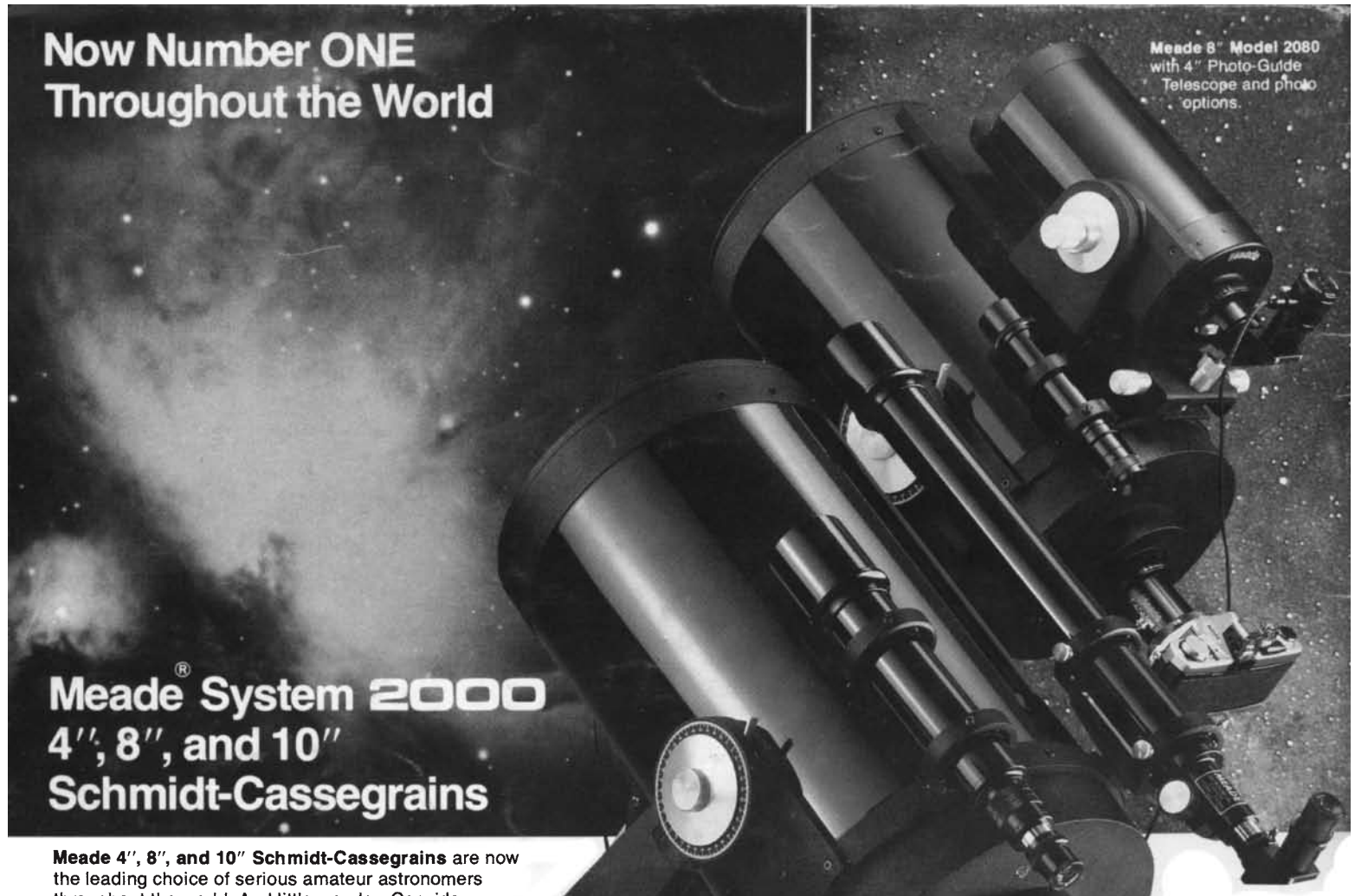

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